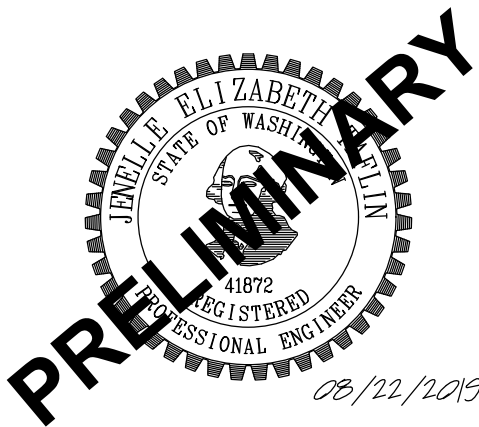


STORMWATER DRAINAGE REPORT

MV TRANSPORTATION FACILITY EXPANSION
REDMOND, WASHINGTON



August 22, 2019

Prepared for:

City of Redmond
15670 NE 85th Street
Redmond, WA 98073

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PROJECT OVERVIEW

PROPOSED IMPROVEMENTS

The proposed development consists of a 324-stall auxiliary parking lot for MV Transit on a 4.13-acre site at Lot 3 of the Union Hill Corporate Center Short Plat in Redmond, Washington. Retaining walls are proposed for portions of the northern, eastern, and western edges of the site. The site will have 2.89 acres of new impervious surface. The property is zoned MP (Manufacturing Park).

DESIGN CRITERIA

The City of Redmond utilizes the 2012 Washington State Department of Ecology Stormwater Management Manual for Western Washington with 2014 Amendments (2014 DOE Manual) drainage requirements with amendments per the 2019 City of Redmond Stormwater Technical Notebook. Stormwater generated on-site will be routed to a proposed detention tank that is sized for the total new impervious surface area (125,952 SF) and pervious surface (9,104 SF).

Table 1 below summarizes the City of Redmond Stormwater Technical Notebook requirements.

JURISDICTIONAL REQUIREMENTS	
Duration Analysis	
2-year:	Reduce to ½ pre-developed duration
50-year:	Match pre-developed
Water Quality Volume:	6-month, 24-hour storm
Water Quality Flow Rate:	Full 2-year release rate from the detention facility*
Downstream Analysis:	Lesser of 1 mile or to the receiving water, unless receiving water is within ¼ mile of the site. If a receiving water is within ¼ mile the analysis shall extend ¼ mile
Conveyance Analysis:	50-yr developed, 24 hr
*All continuous modelling to be performed using the “Puget East 36” precipitation time series, available in WWHM2012 by using WS-DOT data	

PROJECT LOCATION

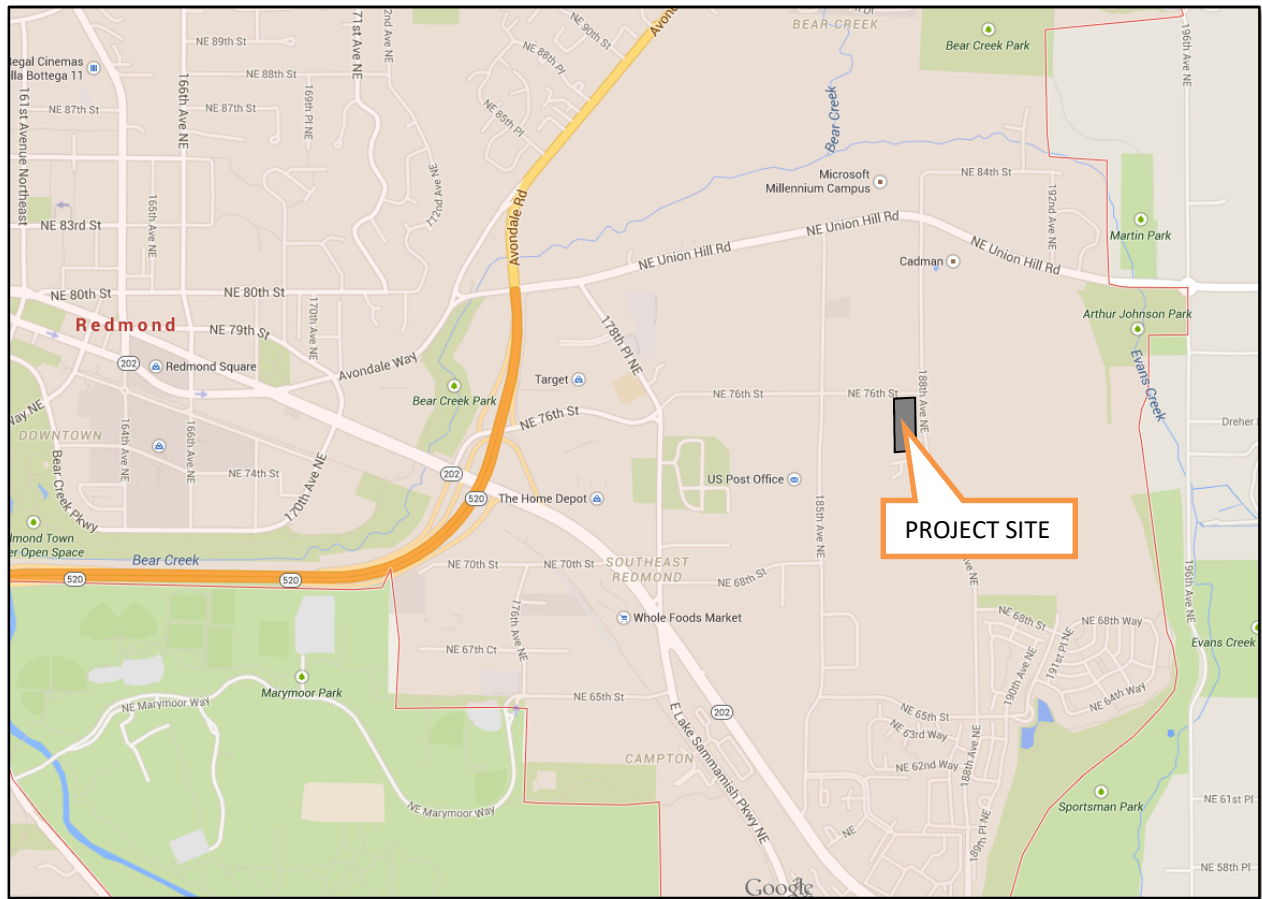


Figure 1: Vicinity Map

Location: Lot 3 of the Union Hill Corporate Center in Redmond, WA

Section, Township, Range: NW ¼, Section 07, Township 25 N, Range 6 E W. M.

Parcel Number: 0725069141

Size: Approximately 179,936 SF (4.13 AC)

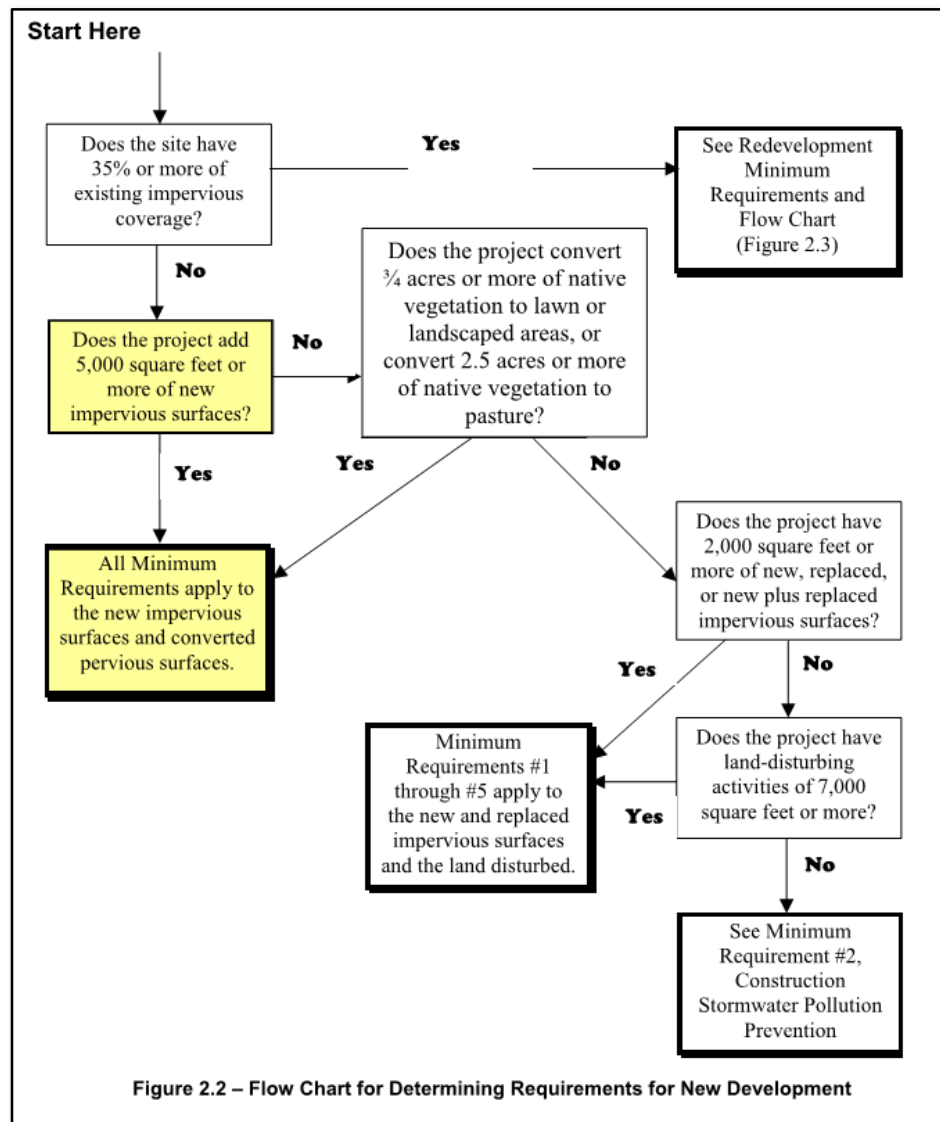
City, County, State: Redmond, King County, Washington State

Governing Agency: City of Redmond

Design Criteria: 2014 DOE Manual with amendments per the 2019 City of Redmond Stormwater Technical Notebook. Minimum Requirement #5 shall be addressed per the 2012 Department of Ecology Feasibility Criteria.

Zoning: Manufacturing Park (MP)

MINIMUM REQUIREMENTS



Minimum Requirement #1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 2.4 shall prepare a Stormwater Site Plan for City review. Stormwater Site Plans (Stormwater Reports) shall use site-appropriate low impact development principles, as required and encouraged by development codes, to retain native vegetation and minimize impervious surfaces to the extent feasible. Stormwater Site Plans shall be prepared in accordance with Volume I, Chapter 3 of the 2014 SWMMWW.

Response: A stormwater site plan has been prepared for the proposed development that incorporates site-appropriate low impact development principles to the maximum extent feasible. The stormwater site plan includes the design drawings and this report.

Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPPP)

All new development, redevelopment and maintenance projects are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters.

Projects which result in 2,000 square feet or more of new plus replaced hard surface area, or which disturb 7,000 square feet or more of land must prepare a Construction SWPP Plan (SWPPP) and TESC plan sheet as part of the Stormwater Site Plan (see Section 2.5.1).

Projects that result in less than 2,000 square feet of new plus replaced hard surface area or disturb less than 7,000 square feet of land are not required to prepare a Construction SWPPP but must consider all of the 13 Elements of Construction Stormwater Pollution Prevention and develop controls for all elements that pertain to the project site.

Response: *The 13 elements of a SWPPP are addressed in the Construction SWPPP section of this report. A full Construction SWPPP is also included under separate cover per City of Redmond requirements.*

Minimum Requirement #3: Source Control of Pollution

All known, available and reasonable source control BMPs must be applied to all projects. Source control BMPs must be selected, designed, and maintained in accordance with the 2014 SWMMWW.

Response: *All available and reasonable source control BMPs will be applied to this project. This includes, but is not limited to, the following:*

- *Dust Control at Disturbed Land Areas*
- *Landscaping and Lawn/Vegetation Management*
- *Maintenance of Stormwater Drainage and Treatment Systems*
- *Soil Erosion and Sediment Control at Industrial Sites*

The full Construction SWPPP (under separate cover) includes the full list and descriptions of applicable BMPs.

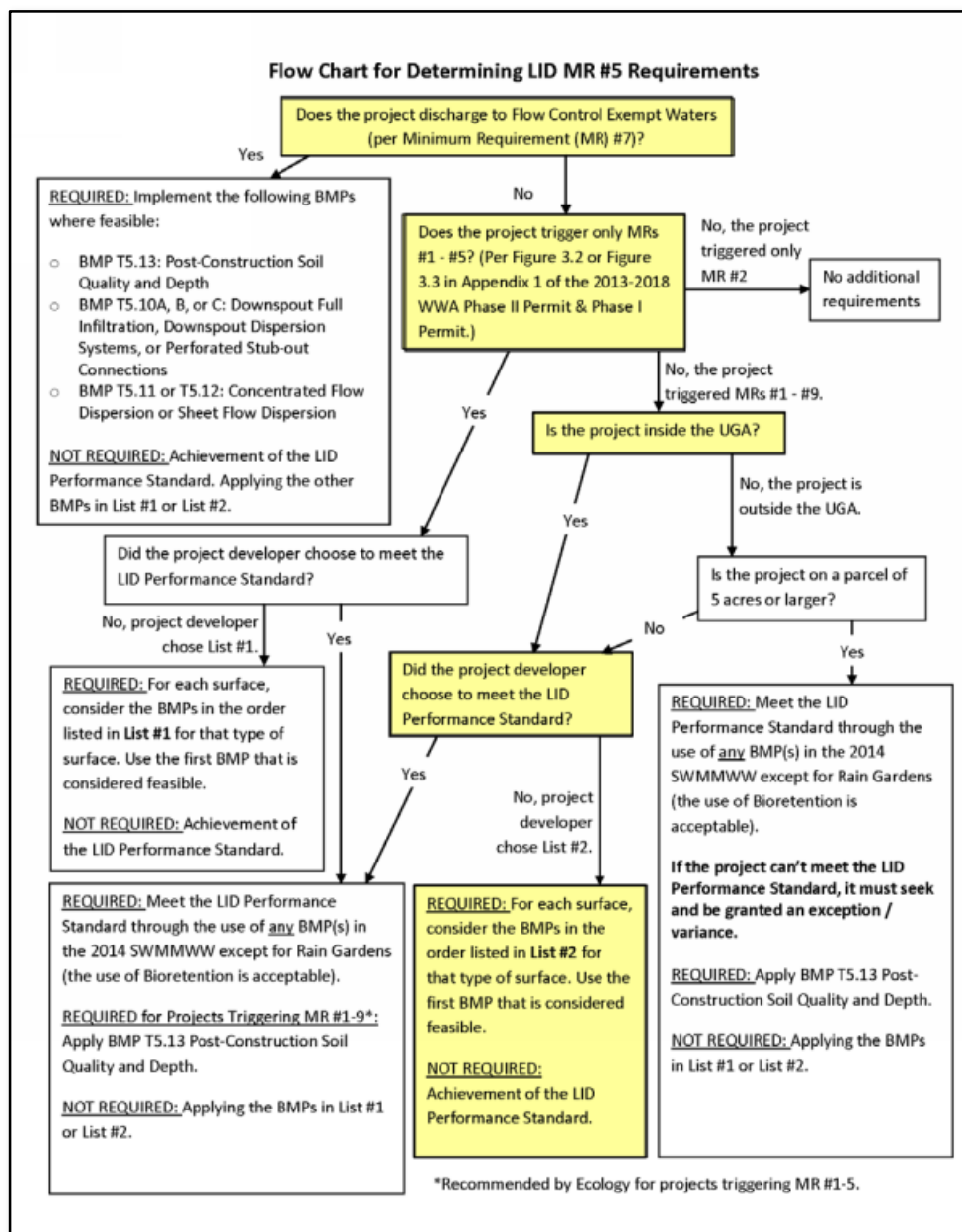
Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down gradient properties. All outfalls require energy dissipation.

Response: *A majority of the runoff from the proposed project will be collected on-site via a series and catch basin then conveyed underground detention facility before be control released to the existing downstream conveyance system located in NE 188th Street that discharges to an existing combination water quality/detention pond (Detention Pond A, Union Hill Metro) as described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012.*

A small portion of the sloped pervious areas along the project boundaries will continue to surface drain along its existing flow path.

Minimum Requirement #5: On-site Stormwater Management



Projects shall employ on-site stormwater management BMPs in accordance with the project thresholds, standards, and lists in section 2.5.5 of the 2109 Redmond Stormwater Technical Notebook to infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing groundwater contamination, flooding, or erosion impacts.

“Flooding and erosion impacts” include impacts such as flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement/settlement, increased landslide potential; erosion and other potential damage.

Infiltrating runoff from pollution generating hard surfaces in Critical Aquifer Recharge Area I is prohibited.

Response: *The BMPs in List #2 (below) were evaluated for feasibility for each type of surface. The first BMP that was determined feasible was selected for on-site use.*

Lawn and Landscaped Areas:

- ***Post-Construction Soil Quality and Depth: Determined feasible and will be provided to the maximum extent possible.***

Roofs:

- *Full Dispersion: Building construction is not a part of this project; therefore, this BMP is not applicable.*
- *Bioretention: Building construction is not a part of this project; therefore, this BMP is not applicable.*
- *Downspout Dispersion Systems: Building construction is not a part of this project; therefore, this BMP is not applicable.*
- *Perforated Stub-out Connections: Building construction is not a part of this project; therefore, this BMP is not applicable.*

Other Hard Surfaces:

- *Full Dispersion: Determined infeasible, as there is insufficient area to provide the required vegetated flowpath on-site with the required vegetated flowpath setbacks from the proposed walls and property line.*
- *Permeable pavement: Determined infeasible, as the project site is located within Wellhead Protection Zone 2 (See Figure 2 below), in which infiltrating runoff from on-site pollution generating impervious surface is prohibited.*
- *Bioretention BMPs: Determined infeasible, as the project site is located within Wellhead Protection Zone 2 (See Figure 2 below), in which infiltrating runoff from on-site pollution-generating impervious surface is prohibited. Other hard surfaces (sidewalk) runoff onto pollution-generating impervious surface.*
- *Sheet Flow Dispersion: Determined infeasible, as there is insufficient area to provide the required vegetated flowpath on-site with the required vegetated flowpath setbacks from the proposed walls and property line.*

As indicated above, all finished landscape areas on-site will contain compost amended soils.

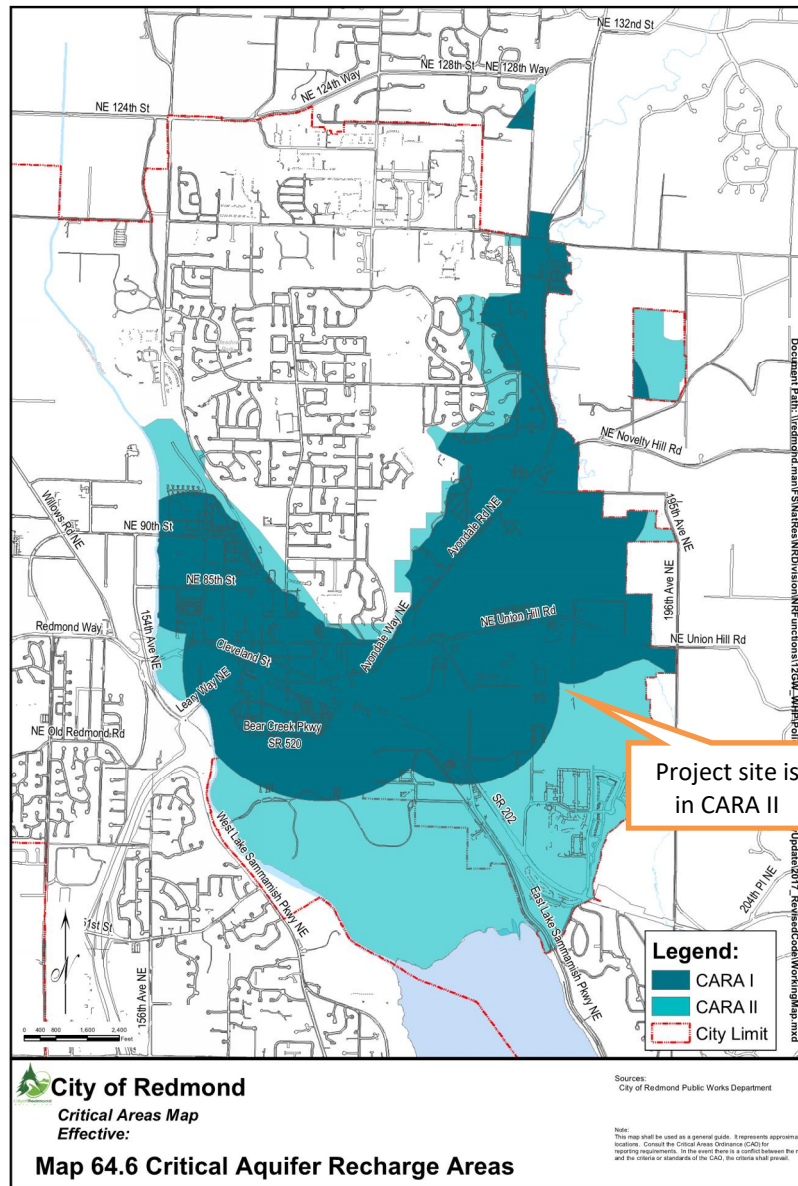


Figure 2: City of Redmond Wellhead Protection Zones

Minimum Requirement #6: Runoff Treatment

The following require construction of stormwater treatment facilities:

- Projects in which the total of pollution generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total of pollution-generating pervious surfaces (PGPS) –not including permeable pavements - is three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system

If the PGIS for a high-use site exceeds 5,000 square feet in threshold discharge area, an oil control BMP from the Oil Control Menu is necessary. High use site are characterized by the following:

- Is subject to an expected average daily vehicle traffic (ADT) count equal to or greater than 100 vehicles per 1,000 square feet of gross building area: or
- Is subject to storage of a fleet of 25 or more diesel vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.).

Response: *Enhanced water quality treatment for the PGIS will be provided through an existing combination detention/water quality pond (Detention Pond A, Union Hill Metro) that was adequately sized to treat runoff from the project site as described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012. The existing pond provides detention and enhanced water quality treatment. Specifically, the existing pond was oversized to accommodate 1.5 times the base water quality treatment volume needed in order to provide for enhanced water quality treatment.*

This site is considered a high-use site. Therefore, an oil/water separator will be provided to treat pavement run-off prior to discharging to the municipal system.

Minimum Requirement #7: Flow Control

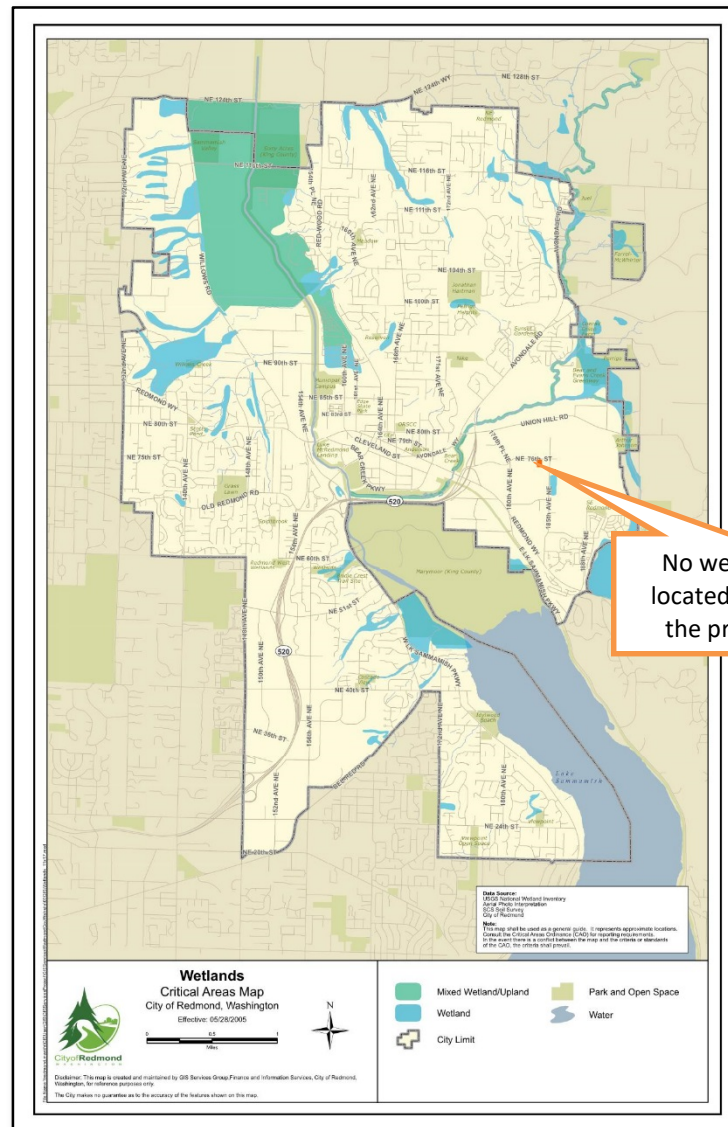
Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The requirement below applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a fresh waterbody.

Response: *Flow control for project areas will be provided by approx. 1,350 linear feet of 8-foot detention tank which is designed in accordance with the 2014 DOE Manual and will be control released to the municipal stormwater conveyance system. See the Flow Control Section of this report for additional information.*

Minimum Requirement #8: Wetlands Protection

The wetland protection requirements apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. These requirements must be met in addition to meeting Minimum Requirement #6, Runoff Treatment.

Response: *As shown in Figure 3 below, the site does not have any existing wetlands. Therefore, no wetlands will be impacted as part of this project.*



Minimum Requirement #9: Operation and Maintenance

An operation and maintenance manual that is consistent with the provisions in Volume V of the DOE manual shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. At private facilities, a copy of the manual shall be retained onsite or within reasonable access to the site, and shall be transferred with the property to the new owner. For public facilities, a copy of the manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the local government.

Response: An Operation and Maintenance Manual will be provided in the next submittal of the storm report and under a separate cover per City of Redmond requirements.

EXISTING CONDITIONS

The proposed parking lot development is located at Lot 3 of the Union Hill Corporate Center in Redmond, Washington. The subject property is 4.13 acres in size. The property is bordered by a MV Transit Garage and Union Hill Self-Storage to the west, NE 76th Street to the north, NE 73rd Street to the south, and 188th Ave NE to the east. See Appendix A for the Existing Conditions Exhibit.

Pre-Development Stormwater Runoff

The property is currently undeveloped and drains to an existing sediment pond in the north east corner of the site. The existing sediment pond outfalls to an existing 30" stub off 188th Street, which flows north through the existing conveyance system within 188th Street, ultimately discharging to the existing Regional Detention Pond A (Union Hill Metro Site).



Figure 4: Existing Drainage Basins Map

Soils Conditions

Per the Geotechnical Engineering Evaluation by Nelson Geotechnical Associates, Inc., dated August 22, 2019, on-site soil conditions consist of surficial layer brown, silty, fine to medium sand with gravel, organics, and varying amounts of anthropogenic debris, including brick, plastic, and processed wood. This material extended to depths of 5.5 to 8 feet below the existing surface the existing surface and was encountered in a loose to medium dense condition.

Groundwater seepage was encountered in the explorations where historic sediment settle ponds had been present. At these test pit locations, the groundwater was 5.5-feet to 10-feet below grade.

Due to the nature and thickness of the fill soils, infiltration is not recommended by the geotechnical engineer.

See Appendix D for the detailed geotechnical engineering report.

DEVELOPED CONDITIONS

The proposed development consists of a new parking lot on a 4.13-acre site on Lot 3 Union Hill Corporate Center in Redmond, Washington. The site will be comprised of 2.89-acres of impervious surface with the remainder of the site being pervious surface. The property is zoned MP (Manufacturing Park).

See Appendix A for the Developed Conditions Exhibit.

Post-Development Stormwater Runoff

Stormwater will be collected on the project site and managed in accordance with the 2014 DOE Manual and amendments per the 2017 City of Redmond Stormwater Technical Notebook.

In the developed conditions, drainage will be divided into two distinct basins. The on-site basin will flow to a new on-site detention tank and the off-site basin will continue to flow to Regional Pond A. See Figure 5 for the developed conditions.

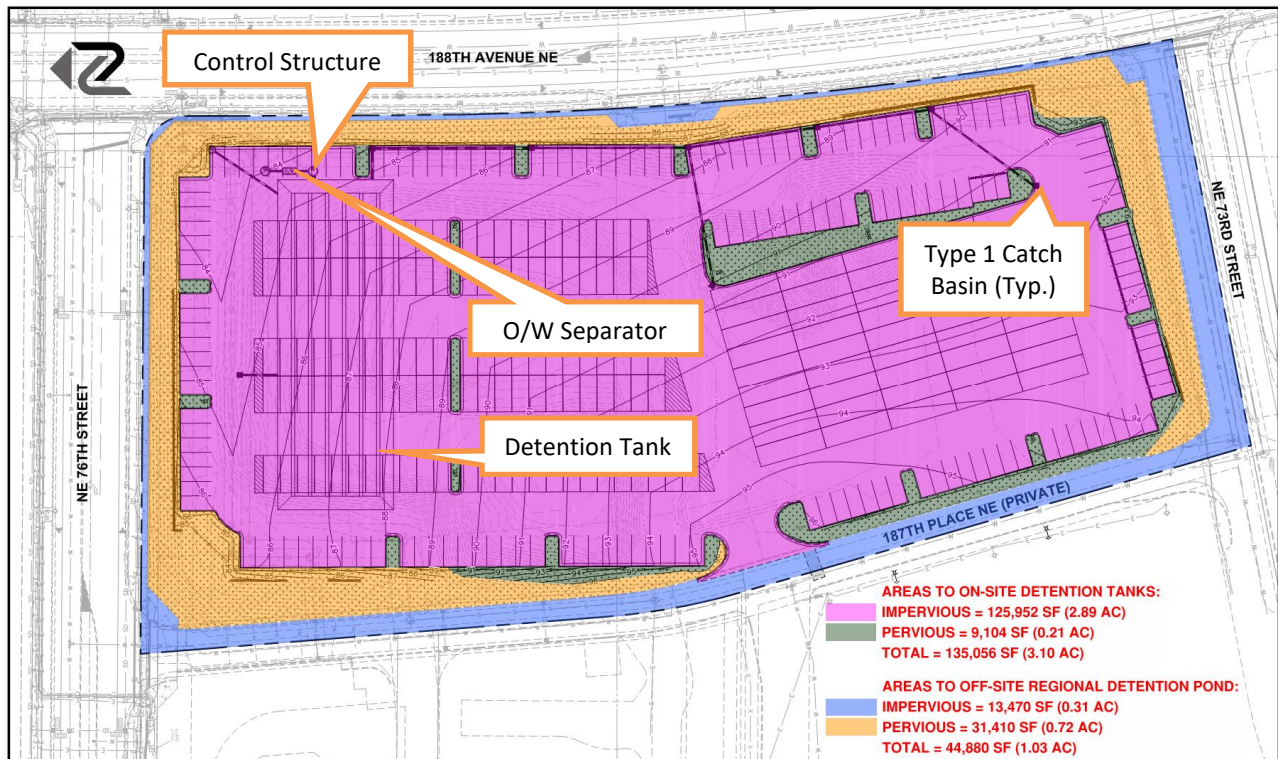


Figure 5: Proposed Drainage Basins

The existing Regional Detention Pond A (Union Hill Metro Site), located northwest of the project site, was designed and constructed to provide flow control and enhanced water quality treatment for runoff flows from the Union Hill Corporate Center Short Plat, including runoff from the project site (Lot 4 of the short plat). As described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012, the project site is allowed to contribute up to 60% pollution-generating impervious area (2.47 acres PGIS) in addition to 20% non-pollution generating impervious area (0.83 acres NPGIS) and 20% landscaping/ pervious surface area (0.83 acres).

In the off-site basin, approximately 0.31 acres of impervious surface area and 0.72 acres of pervious surface area will be tributary to the existing regional pond. These areas are within the existing pond capacity design thresholds; therefore, the existing pond has sufficient capacity to accommodate both water quality treatment and flow control for this development.

Table 2 below shows the proposed and allowed PGIS and NPGIS areas.

Table 2 Off-Site Drainage Basin				
Provided Area		Allowable Area		Description
(AC)	(SF)	(AC)	(SF)	
0.07	3,413	0.83	36,155	Total NPGIS Area
0.24	10,057	2.47	107,942	Total PGIS Area
0.72	31,410	0.83	36,155	Total Pervious
1.03	44,880	4.13	179,936	Total Impervious Area

See the Permanent Stormwater Control Plan section for further details regarding the proposed on-site drainage basins.

OFFSITE ANALYSIS

The upstream and downstream analyses were performed on August 21, 2019.

Task 1: Study Area Definition and Maps

Available resources such as the survey and topographic maps were utilized to prepare the downstream analysis. The study area extended downstream 1/4-mile, at which point the site discharge is contained within a municipal storm main in NE 76th Street. The system ultimately discharges into Bear Creek.

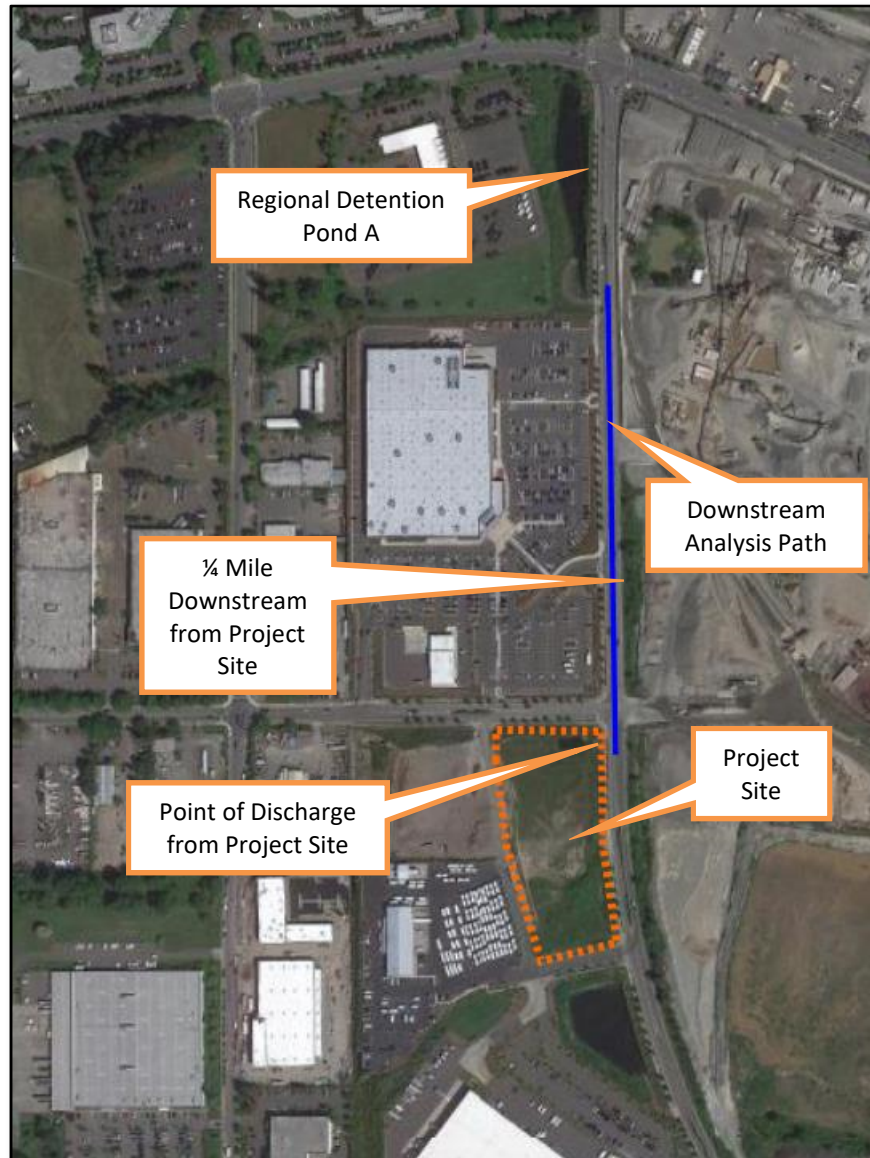


Figure 6: Downstream Analysis

In the current site conditions, there is no upstream runoff from the MV Transit site or Union Hill Self-Storage sites onto the project site. Because there is no upstream tributary flow to the project site, the study area was not extended upstream but was limited to the project site boundary.

Task 2: Resource Review

The following resources were reviewed as part of the offsite analysis:

- City of Redmond Watershed Map
- City of Redmond Frequently Flooded Areas Map
- City of Redmond Critical Aquifer Recharge Area (CARA) Map
- City of Redmond Wetlands Map

Figure 7 shows the location of the project site outside of the 100-year flood plain.

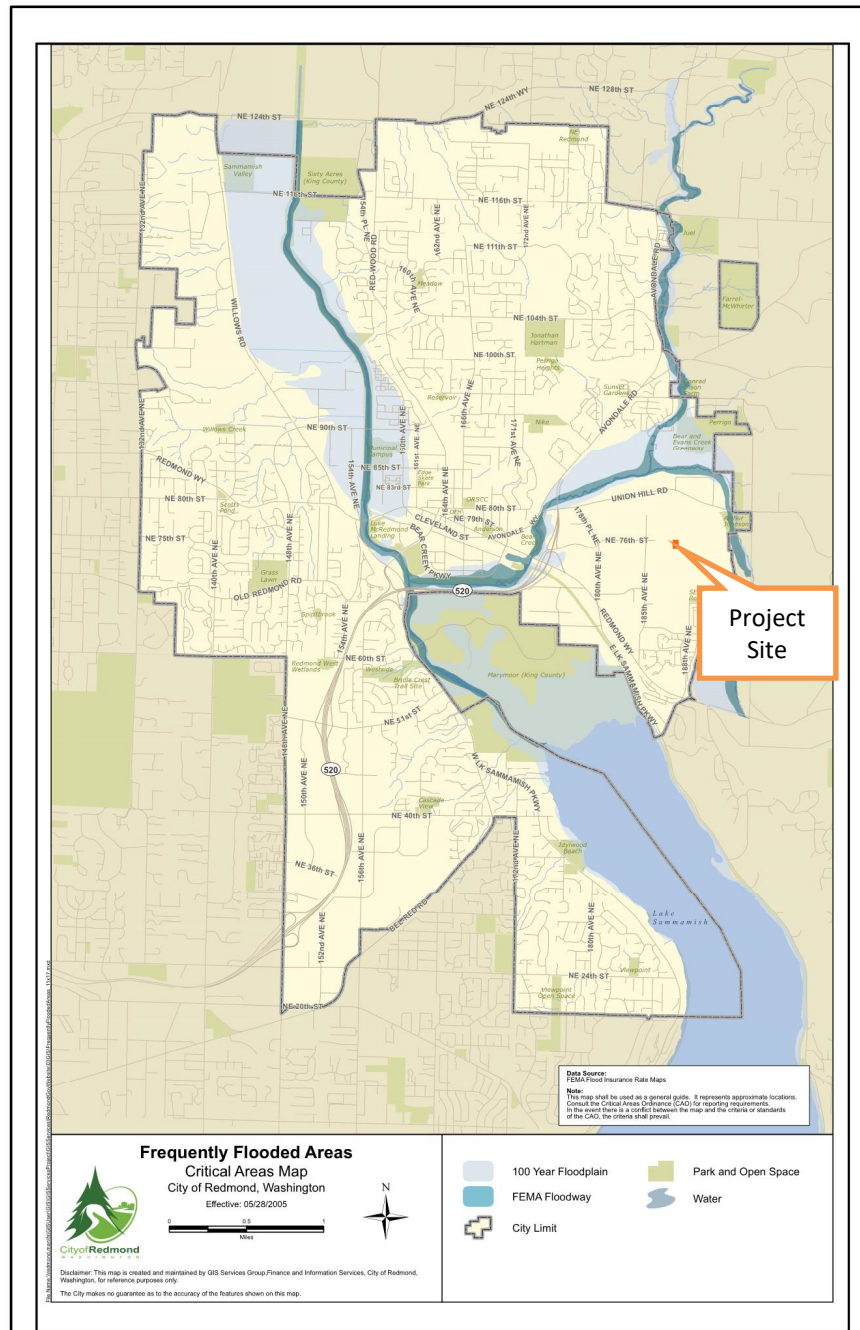


Figure 7: Frequently Flooded Areas Map

Figure 8 shows the location of the project site within the Bear Creek and Evans Creek watershed.

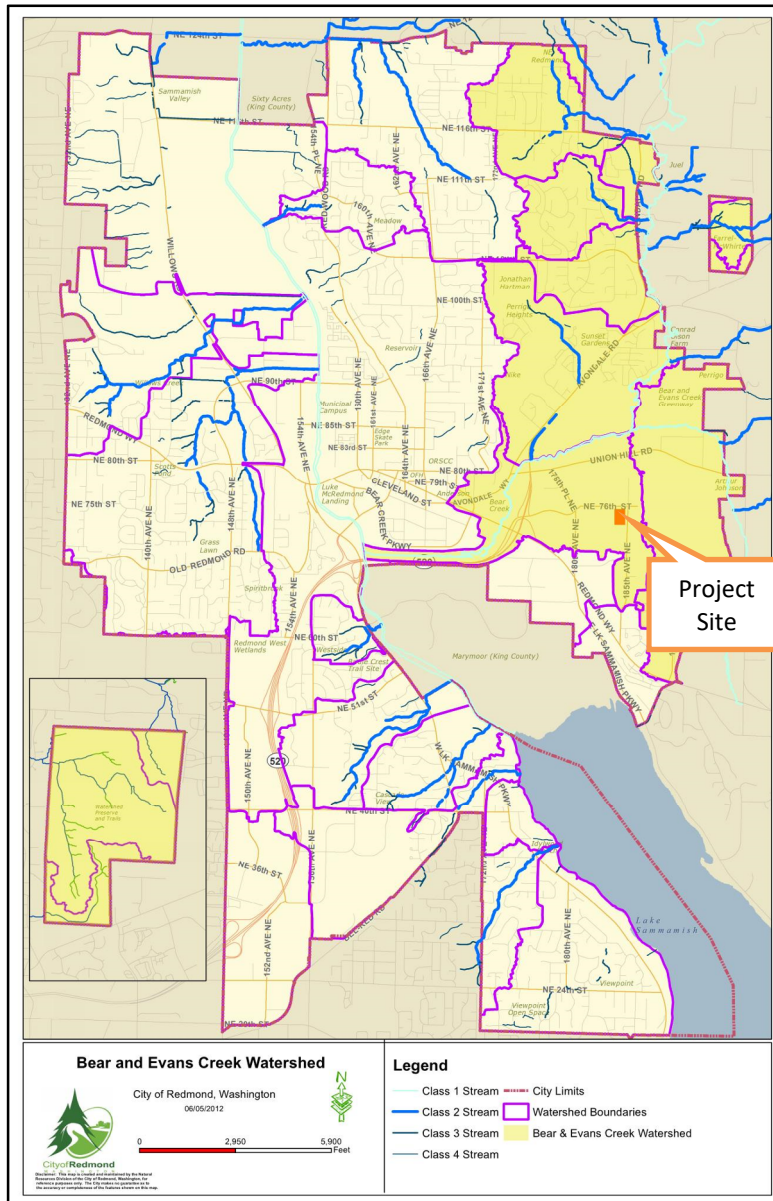


Figure 8: Watershed Map

As shown in Figure 2 in the Minimum Requirements section of this report, the project site is located within Critical Aquifer Recharge Area II. The project does not propose the storage, handling, production, treatment, or use of any hazardous materials on-site.

As shown in Figure 3 in the Minimum Requirements section of this report, no wetlands or other sensitive/critical areas were found to be present on the project site or in the nearby vicinity that would be impacted by the proposed development.

Task 3: Field Inspection

The existing Lot 3 sheet flows and stormwater runoff from portions of this 4.13-acre site drains to an existing sediment pond on the adjacent property to the east. The existing sediment pond outfalls to an existing 30" stub off 188th Street, which flows north through the existing conveyance system within 188th Street, ultimately discharging to an existing combination water quality/detention pond (Detention Pond A, Union Hill Metro) as described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012.

#	Photo	Description
1		<p>Looking west from 188th to the adjacent property (east of the project site).</p> <p>The ditch outfalls into a temporary pond on the adjacent property with a gravel riser.</p>
2		<p>Looking east from the temporary pond.</p> <p>The pond outfall connects to the existing 30" pipe, which runs north along 188th to the existing Regional Detention Pond A.</p>

Task 4: Describe the Drainage System and its Existing and Predicted Problems

In the existing condition, a majority of the project site runoff is tributary to 188th Ave NE system which ultimately discharging to an existing combination water quality/detention pond (Detention Pond A, Union Hill Metro) as described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012. In the developed condition, approx. 1.03 acres of the total 4.13 acre site will continue in it's existing drainage patterns. The remaining 3.10 acres with be collected and routed to the on-site detention tank facility where stormwater will be control released to the existing municipal stormwater system.

PERMANENT STORMWATER CONTROL PLAN

EXISTING SITE HYDROLOGY

Per the 2014 DOE Manual, the pre-developed conditions for the project site have been modeled as completely forested as shown in Table 3 below for each of the two site basins (on-site and off-site). The total site is 4.13 acres. See Appendix A for the Existing Conditions Exhibit.

Table 3 Existing Conditions			
Basin	Proposed Area		Description
	(AC)	(SF)	
On-Site	3.10	135,056	Forest (Pervious)
Off-Site	1.03	44,880	Forest (Pervious)
	4.13	179,936	Total Site Area

DEVELOPED SITE HYDROLOGY

As illustrated in Figure 5 of the Developed Conditions section of this report, the proposed site is divided into two site basins (on-site and off-site). Proposed site surface coverage areas are delineated in Figure 9 below. See the Developed Conditions Exhibit in Appendix A of this report. The contributing site area routed to the regional detention pond are shown in Tables 4a and 4b.

Table 4a Developed Conditions – On-Site		
Proposed Area		Description
(AC)	(SF)	
2.89	125,952	Impervious
0.21	9,104	Pervious
3.10	135,056	Total On-Site Basin

Table 4b Developed Conditions – Off-Site (To Regional Detention Pond)		
Proposed Area		Description
(AC)	(SF)	
0.31	13,470	Impervious
0.72	31,410	Pervious
1.03	44,880	Total Off-Site Basin

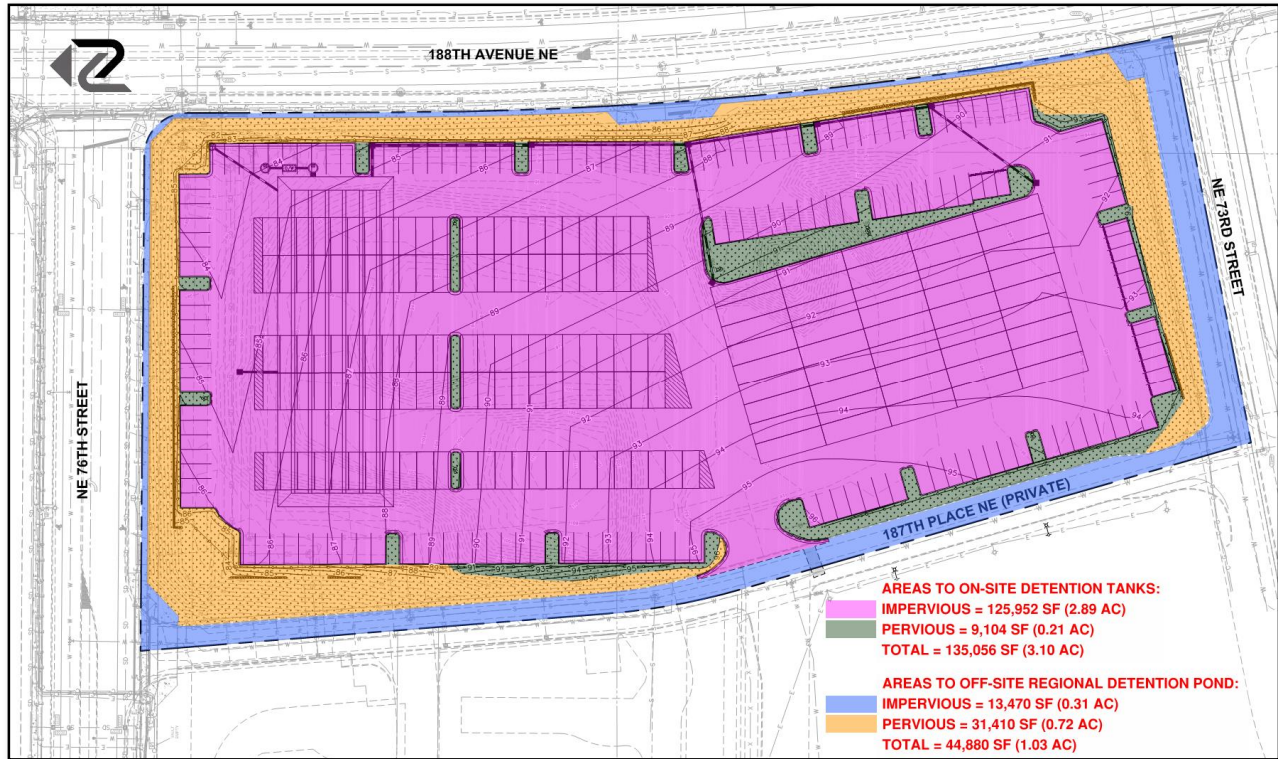


Figure 9: Developed Conditions

NEARBY RECEIVING WATERS

There are no nearby receiving waters that will be negatively impacted by this project. All runoff from the project will be ultimately discharged into Bear Creek approximately 1 mile downstream of the project site. See Offsite Analysis for additional analysis of the downstream conditions.

HYDROLOGIC MODELING

Flow control and enhanced treatment will be provided by an existing combination water quality/detention pond (Detention Pond A, Union Hill Metro) as described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012. Hydrologic modeling was performed for conveyance sizing. See the Conveyance Analysis and Design section for details.

FLOW CONTROL SYSTEM

As described in the Stormwater Drainage Technical Information Report for Regional Detention Pond A, Union Hill Metro Site, by DOWL HKM, dated October 29, 2012, the existing combination water quality/detention pond (Detention Pond A, Union Hill Metro) was sized to provide flow control for 20% of impervious surface area from the 4.13-acre Lot 3 site or 0.826 acres. The remaining 80% of the Lot 3 site or 3.304 acres requires on-site flow control to be provided.

Upon build-out, the Lot 3 development will consist of approximately 2.89 acres of impervious surface area and 0.21 acres of pervious surface area that will be able to be captured and routed to an on-site flow control facility. This totals to 3.10 acres, which is 0.204 acres less than the 3.304 acres originally

required to be managed by an on-site flow control facility (under the forested predeveloped condition). However, only roughly 0.31 acres of impervious surface area is proposed to be directly discharged to the existing combination water quality/detention pond, which is less than the 0.825 acres of impervious surface area or 20% of the Lot 3 site that was accounted for in the design of the existing pond. Therefore, less runoff from the Lot 3 site is being directly discharged to the existing pond by virtue of the decrease in tributary impervious surface area. The existing combination water quality/detention pond should continue to function as originally intended with the proposed Lot 3 development.

The proposed detention system will consist of 1,350 LF of 8-foot diameter CMP tanks. Basin data and results from the WWHM 2012 model are provided in Appendix A.

See Appendix C for WWHM 2012 Input and Output for detailed flow control sizing.

WATER QUALITY SYSTEM

The existing regional combination water quality/detention was designed to provide enhanced water quality for the entire 4.13 Lot 3 site; therefore, on-site water quality treatment is not required.

This site is considered a high-use site. Therefore, an oil/water separator will be provided to treat pavement run-off prior to discharging to the municipal system.

CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The proposed conveyance system will be designed in accordance with the 2017 City of Redmond Stormwater Technical Notebook. A detailed conveyance system analysis will be provided in the next submittal of this report.

100-YEAR FLOOD/OVERFLOW CONDITION

The stormwater conveyance system for this project has been designed to address storm events in accordance with common industry practices. In the event of a larger storm, the system may fail. In this case, the runoff from larger events will overtop the control structure riser then convey stormwater to the existing underground municipal system before ultimately discharging to the existing Regional Detention Pond A (Union Hill Metro Site).

The overflow of Regional Detention Pond A is described in the Pond A TIR.

CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

All erosion and sediment control measures shall be governed by the requirements of the City of Redmond. A temporary erosion and sedimentation control plan has been prepared and full CSWPPP will be provided prior to construction.

TWELVE ELEMENTS OF CSWPPP

Element 1: Mark Clearing Limits

- Prior to beginning land disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area shall be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts.
- Plastic, metal, or stake wire fence may be used to mark the clearing limits.
- The duff layer, native top soil, and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable. If it is not practicable to retain the duff layer in place, it should be stockpiled on-site, covered to prevent erosion, and replaced immediately upon completion of the ground disturbing activities.

Element 2: Establish Construction Access

- Construction vehicle access and exit shall be limited to one route, if possible, or two for linear projects such as roadways where more than one access is necessary for large equipment maneuvering.
- Access points shall be stabilized with a pad of quarry spalls or crushed rock prior to traffic leaving the construction site to minimize the tracking of sediment onto public roads.
- Wheel wash or tire baths should be located on-site, if applicable.
- If sediment is tracked off site, public roads shall be cleaned thoroughly at the end of each day, or more frequently during wet weather, if necessary to prevent sediment from entering waters of the state. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will be allowed only after sediment is removed in this manner.
- Street wash wastewater shall be controlled by pumping back onsite, or otherwise be prevented from discharging into systems tributary to state surface waters.

Element 3: Control Flow Rates

- Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site, as required by local plan approval authority.
- Downstream analysis is necessary if changes in flows could impair or alter conveyance systems, stream banks, bed sediment or aquatic habitat.
- Where necessary to comply with Minimum Requirement #7, stormwater retention/detention facilities shall be constructed as one of the first steps in grading. Detention facilities shall be functional prior to construction of site improvements (e. g. impervious surfaces).
- The local permitting agency may require pond designs that provide additional or different stormwater flow control if necessary to address local conditions or to protect properties and waterways downstream from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.
- If permanent infiltration ponds are used for flow control during construction, these facilities should be protected from siltation during the construction phase.

Element 4: Install Sediment Controls

- Prior to leaving a construction site, or prior to discharge to an infiltration facility, stormwater runoff from disturbed areas shall pass through a sediment pond or other appropriate sediment removal BMP. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Element #3, bullet #1. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion. The Local Permitting Authority shall inspect and approve areas stabilized by means other than pavement or quarry spalls.
- Sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment on-site shall be constructed as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
- Earthen structures such as dams, dikes, and diversions shall be seeded and mulched according to the timing indicated in Element #5.
- BMPs intended to trap sediment on site must be located in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages, often during non-storm events, in response to rain event changes in stream elevation or wetted area.

Element 5: Stabilize Soils

- All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion.
- From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days. From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days. This condition applies to all soils on site, whether at final grade or not. These time limits may be adjusted by the local permitting authority if it can be shown that the average time between storm events justifies a different standard.
- Soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.
- Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), the early application of gravel base on areas to be paved, and dust control.
- Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.
- Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways and drainage channels.
- Linear construction activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirement. Contractors shall install the bedding materials, roadbeds, structures, pipelines, or utilities and re-stabilize the disturbed soils so that:
 - from October 1 through April 30 no soils shall remain exposed and unworked for more than 2 days; and
 - from May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days.

Element 6: Protect Slopes

- Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.
- Consider soil type and its potential for erosion.

- Reduce slope runoff velocities by reducing the continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surface.
- Off-site stormwater (run-on) shall be diverted away from slopes and disturbed areas with interceptor dikes and/or swales. Off-site stormwater should be managed separately from stormwater generated on the site.
- At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. Temporary pipe slope drains shall handle the peak flow from a 10 year, 24 hour event assuming a Type 1A rainfall distribution. Alternatively, the 10-year and 25-year, 1-hour flow rates indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. Consult the local drainage requirements for sizing permanent pipe slope drains.
- Provide drainage to remove ground water intersecting the slope surface of exposed soil areas.
- Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.
- Check dams shall be placed at regular intervals within channels that are cut down a slope.
- Stabilize soils on slopes, as specified in Element #5.

Element 7: Protect Drain Inlets

- All storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.
- All approach roads shall be kept clean. All sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the State.
- Inlets should be inspected weekly at a minimum and daily during storm events. Inlet protection devices should be cleaned or removed and replaced when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

Element 8: Stabilize Channels and Outlets

- All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from the expected peak 10 minute velocity of flow from a Type 1A, 10- year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used.
- Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

Element 9: Control Pollutants

- All pollutants, including waste materials and demolition debris, that occur on-site shall be handled and disposed of in a manner that does not cause contamination of stormwater. Woody debris may be chopped and spread on site.
- Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste). On-site fueling tanks shall include secondary containment.
- Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

- Wheel wash or tire bath wastewater, shall be discharged to a separate on-site treatment system or to the sanitary sewer.
- Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application rates and procedures shall be followed.
- BMPs shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. These sources include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.
- Construction sites with significant concrete work shall adjust the pH of stormwater if necessary to prevent violations of water quality standards.

Element 10: Control De-Watering

- Foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Element #8.
- Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to state surface waters, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters. These clean waters should not be routed through a stormwater sediment pond.
- Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater.
- Other disposal options, depending on site constraints, may include: 1) infiltration, 2) transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters, 3) Ecology-approved on-site chemical treatment or other suitable treatment technologies, 4) sanitary sewer discharge with local sewer district approval, if there is no other option, or 5) use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.

Element 11: Maintain BMPs

- All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMP specifications.
- All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

Element 12: Manage the Project

- Phasing of Construction - Development projects shall be phased where feasible in order to prevent soil erosion and, to the maximum extent practicable, the transport of sediment from the site during construction. Re-vegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.
- Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e. g. , subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing

disturbance/compaction of native soils except as needed for building purposes. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas as may be required by local jurisdictions, shall be delineated on the site plans and the development site.

- Seasonal Work Limitations - From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
 1. Site conditions including existing vegetative coverage, slope, soil type and proximity to receiving waters; and
 2. Limitations on activities and the extent of disturbed areas; and
 3. Proposed erosion and sediment control measures.

Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance. The local permitting authority shall take enforcement action - such as a notice of violation, administrative order, penalty, or stop-work order under the following circumstances:

- If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard; or
- If clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained.

The following activities are exempt from the seasonal clearing and grading limitations:

1. Routine maintenance and necessary repair of erosion and sediment control BMPs;
 2. Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
 3. Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.
- Coordination with Utilities and Other Contractors - The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

Inspection and Monitoring - All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have the skills to 1) assess the site conditions and construction activities that could impact the quality of stormwater, and 2) assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

- For construction sites one acre or larger that discharge stormwater to surface waters of the state, a Certified Erosion and Sediment Control Specialist shall be identified in the Construction SWPPP and shall be on-site or on-call at all times. Certification may be obtained through an approved training program that meets the erosion and sediment control training standards established by Ecology. Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.
- Maintaining an Updated Construction SWPPP - The Construction SWPPP shall be retained on-site or within reasonable access to the site.

The SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The SWPPP shall be modified, if during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) calendar days following the inspection.

Element 13: Protect LID BMPs

- Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the Bioretention and/or Rain Garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/rain garden soils and replacing the removed soils with soils meeting the design specification.
- Prevent compacting Bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements.
- Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from the local stormwater manual or the manufacturer's procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

ESC ANALYSIS AND DESIGN

Trapping Sediment

Structural control measures will be used to reduce erosion and retain sediment on the construction site. The control measures will be selected to fit specific site and seasonal conditions.

The following structural items will be used to control erosion and sedimentation processes:

- Stabilized construction entrances
- Filter fabric fences
- Catch Basin Inlet Sediment Protection
- Proper Cover measures
- Temporary swales
- Sediment pond and Trap
- Rock check dam

Weekly inspection of the erosion control measures will be required during construction. Any sediment buildup shall be removed and disposed of off-site. Vehicle tracking of mud off-site shall be avoided. Installation of a stabilized construction entrance will be installed at a location to enter the site. The

entrances are a minimum requirement and may be supplemented if tracking of mud onto public streets becomes excessive. In the event that mud is tracked off site, it shall be swept up and disposed of off-site on a daily basis. Depending on the amount of tracked mud, a vehicle road sweeper may be required.

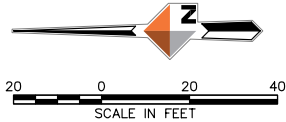
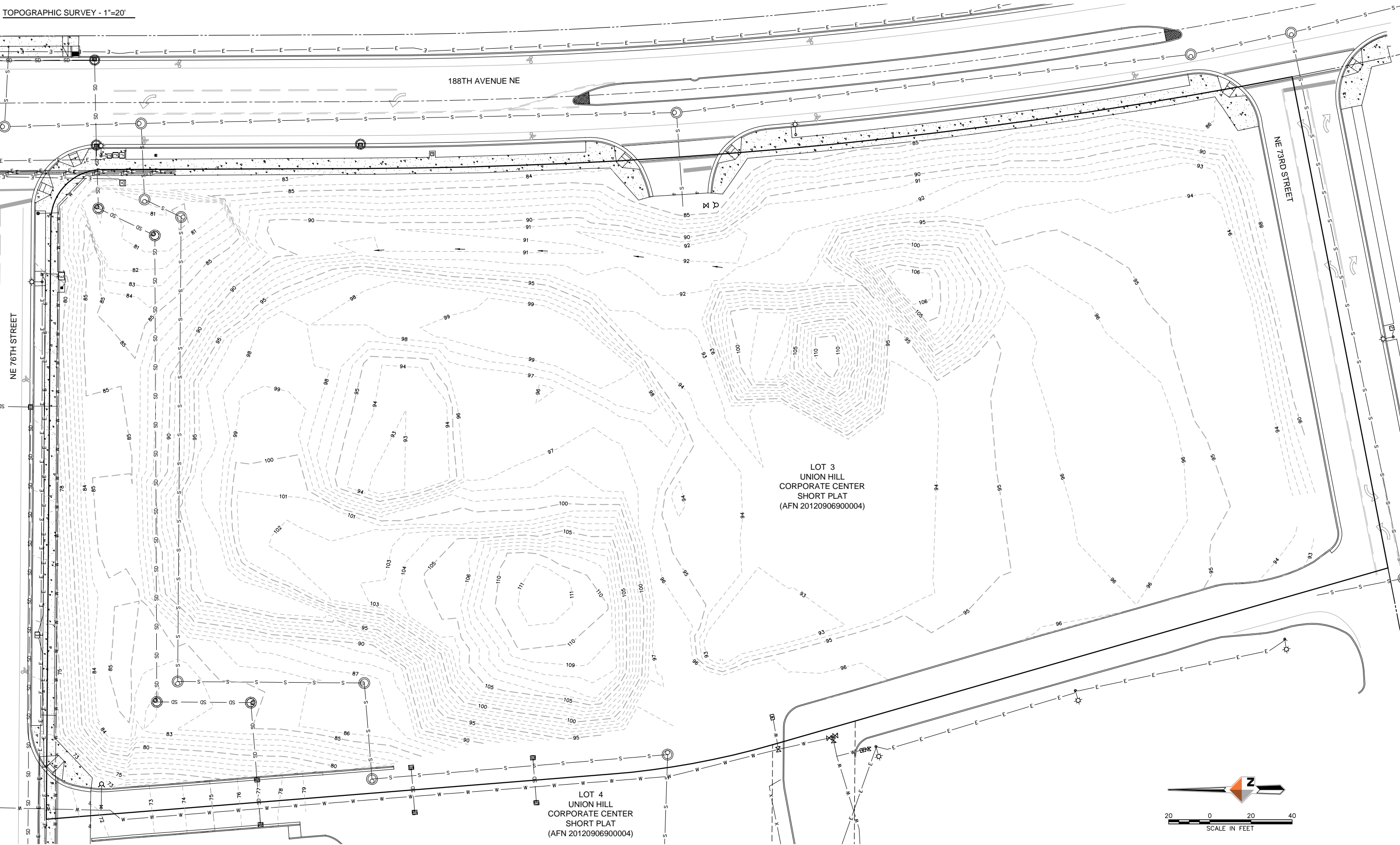
Because vegetative cover is the most important form of erosion control, construction practices must adhere to stringent cover requirements. More specifically, the contractor will not be allowed to leave soils open for more than 14 days and, in some cases, immediate seeding will be required.

Temporary Sediment Trap

A temporary sediment trap will be sized using WWHM2012 in accordance with the 2017 City of Redmond Stormwater Technical Notebook and provided in the next submittal of the storm report.

APPENDIX A

SITE EXHIBITS



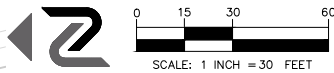
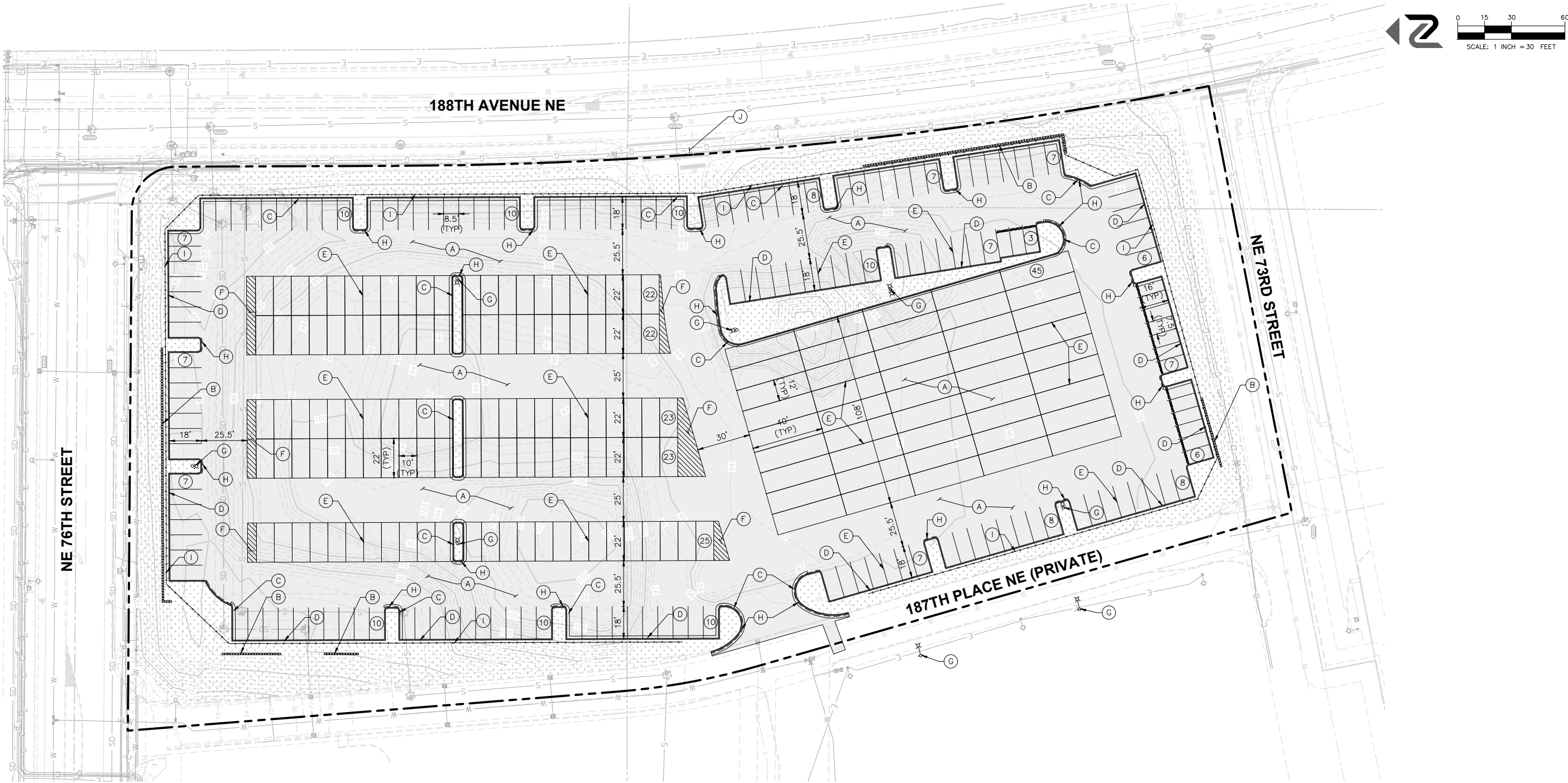
REVISIONS			
REV	DATE	DESCRIPTION	BY



TOPOGRAPHIC SURVEY
LOT 3, UNION HILL CORPORATE CENTER
REDMOND, WASHINGTON

PROJECT	13825.01
DATE	11/28/2018
SHEET	
1	OF 1

c:\27\13825-01\990deliver\99.5 Survey Documents\2018-11-26 Lot 3 Cad\MCI4-VB-BA-13825-01.dwg PLOT DATE 2018-11-28 08:03 SAVED DATE 2018-11-26 14:39 USER: price



LEGEND:

- PROPERTY LINE
- CONCRETE VERTICAL CURB
- CONCRETE CURB AND GUTTER
- ASPHALT PAVEMENT
- LANDSCAPE AREA
- # NUMBER OF PARKING STALLS

SITE DATA:

TOTAL PROPERTY AREA: ±179,936 SF (4.13 ACRES)
IMPERVIOUS: 139,422 SF (77.5% OF 179,936 SF)
LANDSCAPE: 40,514 SF (22.5% OF 179,936 SF)

ALLOWED COVERAGE
80% IMPERVIOUS
20% LANDSCAPE

PROPOSED CAR PARKING
STANDARD STALLS (8.5'x18'): 149 STALLS
COMPACT STALLS (7.5'x16'): 16 STALLS
SHUTTLE BUS STALLS (10'x22'): 115 STALLS
LARGE BUS STALLS (12'x40'): 45 STALLS
TOTAL: 325 STALLS

SITE KEY:

- (A) ASPHALT PAVEMENT
- (B) KEYSTONE BLOCK WALL PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
- (C) TYPE A-1 CONCRETE CURB AND GUTTER
- (D) CONCRETE VERTICAL CURB
- (E) 4" WIDE SOLID WHITE STRIPE, (TYP.)
- (F) 4" WIDE SOLID WHITE STRIPE AT 45" X 18" SPACING, O.C. (TYP.)
- (G) LIGHT POLE. SEE ILLUMINATION PLAN FOR DETAILS
- (H) FIRE LANE STRIPING. SEE SHEET C-1.4 FOR FIRE LANE STRIPING REQUIREMENTS.
- (I) 8' BLACK VINYL COATED CHAIN LINK FENCE.
- (J) EXISTING 188TH AVE NE ENTRANCE TO REMAIN FOR POTENTIAL FUTURE ACCESS.

NOTE: THIS DEVELOPMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE 2019 CITY OF REDMOND STANDARD SPECIFICATION AND DETAILS.

APPROVED FOR CONSTRUCTION

FOR: DIRECTOR OF PUBLIC WORKS
CITY OF REDMOND

DATE:

PLAN CHK ENGR:

STORM:

UTILITY:

FIRE:

TRANS/ENGR:

PLANNING:

THIS APPROVAL IS FOR THE DESIGN CONCEPT ONLY. THESE PLANS APPEAR TO BE IN CONFORMANCE WITH THE CITY OF REDMOND DESIGN STANDARDS FOR CONSTRUCTION. THIS APPROVAL SHALL NOT BE CONSTRUED AS AUTHORIZING CONSTRUCTION NOT IN ACCORDANCE WITH APPLICABLE CITY STANDARDS. THE CITY RESERVES THE RIGHT TO REQUIRE REVISIONS TO THE APPROVED PLANS TO ASSURE CONFORMANCE WITH CITY OF REDMOND DESIGN STANDARDS FOR CONSTRUCTION AT ANY TIME THAT IT IS DISCOVERED THAT THE PROPOSED CONSTRUCTION DOES NOT OTHERWISE MEET THE APPLICABLE CONSTRUCTION STANDARDS. THE OWNER IS REQUIRED TO PROVIDE DESIGNS AND PLANS IN ACCORDANCE WITH APPLICABLE CITY STANDARDS AND ASSURES THAT CONSTRUCTION IS ACCOMPLISHED IN ACCORDANCE WITH THOSE STANDARDS. THE OWNER AND/OR DESIGN ENGINEER AND/OR DEVELOPER MAY BE REQUIRED TO MAKE NECESSARY APPROVED FIELD REVISIONS TO CORRECT ANY ERRORS OR OMISSIONS FOUND ON THE APPROVED PLAN.



NAVIX

SITE | CIVIL

11235 s.e. 6th street | suite 150
bellevue, wa 98004

t: 425.453.9501 | f: 425-453-8208
www.navixeng.com

CLIENT/OWNER

MV TRANSIT

PROJECT NAME

MV TRANSPORTATION
FACILITY EXPANSION

NAVIX PROJECT NUMBER: 50.601.002

PROJECT ADDRESS

NE 76TH STREET AND
188TH AVENUE NE
REDMOND, WA 98052

STAMP



REVISIONS

REV	ISSUED FOR:	DATE
1	PREP SUBMITTAL	08.22.19



SECTION, TOWNSHIP, RANGE:
NE 1/4 OF NW 1/4 OF SECTION 07,
TOWNSHIP 25 NORTH, RANGE 06
EAST, W.M.

PROJECT TEAM

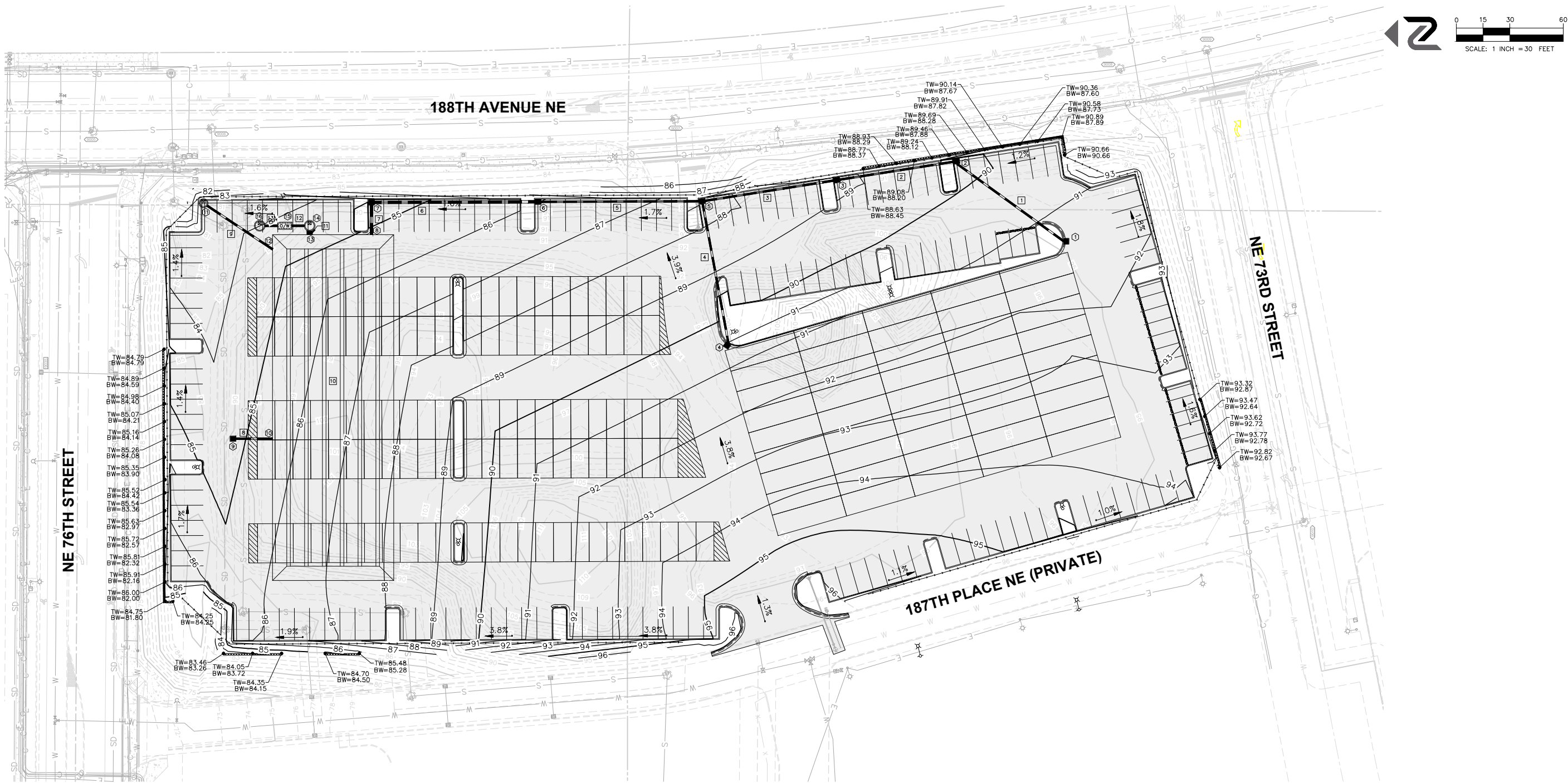
REVIEWED BY: J.TAFLIN
DESIGNED BY: J.GREEN

SHEET NAME

SITE
IMPROVEMENT
PLAN

SHEET NUMBER

C-1.0
19-XXXX



LEGEND:

- SD STORM DRAIN PIPE
- EXISTING STORM DRAIN PIPE
- CATCH BASIN TYPE 1 PER WSDOT STD. PLAN B-5.20-00
- CATCH BASIN TYPE 2 PER WSDOT STD. PLAN B-10.20-00
- 88 MINOR CONTOUR
- 90 MAJOR CONTOUR
- RIDGE --- RIDGE LINE
- xxx.xx SPOT ELEVATION
- x.xx% SLOPE
- KEYSTONE BLOCK WALL

STRUCTURE SCHEDULE			
#	DESCRIPTION	#	DESCRIPTION
①	CB TYPE I (A) RIM = 91.36 12" IE = 88.36	⑪	CB TYPE II-48" (A) RIM = 83.00 12" IE = 81.00
②	CB TYPE I (A) RIM = 89.65 12" IE = 86.65	⑫	DETENTION TANK INLET 12" IE = 80.50
③	CB TYPE I (A) RIM = 88.81 12" IE = 85.81	⑬	DETENTION TANK OULET 36" IE = 73.00
④	CB TYPE I (A) RIM = 90.51 12" IE = 87.51	⑭	CB TYPE II-60" (B) WITH CONTROL STRUCTURE RIM = 84.45 36" IE = 72.95 24" IE = 72.95
⑤	CB TYPE I (A) RIM = 87.34 12" IE = 84.34	⑮	OIL/WATER SEPARATOR RIM = 84.00 12" IE = 72.85
⑥	CB TYPE I (A) RIM = 85.41 12" IE = 82.91 18" IE = 82.41	⑯	CONNECT TO EX. 30" STUB WITH A NEW CB TYPE II-60" (B) RIM = 84.00 12" IE = 72.5± 30" IE = 71.0±
⑦	CB TYPE I (A) RIM = 84.45 18" IE = 80.95		
⑧	DETENTION TANK INLET 18" IE = 80.50	GRATE SCHEDULE (SEE STRUCTURE SCHEDULE FOR GRATE TYPE) A. RECTANGULAR VANED GRATE PER WSDOT STD. PLAN B-30.30-00 B. SOLID RIM PER WSDOT STD. PLAN 30.20-01 C. RECTANGULAR HERRINGBONE GRATE PER WSDOT STD. PLAN 30.50-00	
⑨	CB TYPE I (C) RIM = 84.74 12" IE = 81.74		
⑩	DETENTION TANK INLET 12" IE = 80.50		

PIPE SCHEDULE			
PIPE #	DIAMETER	LENGTH (FT.)	SLOPE (PERCENT)
1	12" PVC	76	2.25%
2	12" PVC	68	1.24%
3	12" PVC	77	1.91%
4	12" PVC	82	3.87%
5	12" PVC	92	1.55%
6	18" PVC	94	1.55%
7	18" PVC	18	2.50%
8	12" PVC	22	5.64%
9	12" D.I.	47	1.06%
10	1350 LF 8" DIA CMP DETENTION TANK @ 0.0%		
11	36" CMP	5	1.00%
12	12" PVC	10	1.00%
13	12" PVC	10	3.50%

CONTRACTOR TO PERFORM SOIL SAMPLING PER SOIL MANAGEMENT PLAN PRIOR TO START OF GRADING ACTIVITIES.

ALL TRENCH/PIPE ZONES SHALL BE OVER-EXCAVATED TO SUPPORT THE UTILITY PIPES AS NEEDED. GEOTECHNICAL ENGINEER AND/OR CITY INSPECTOR SHALL VERIFY.

NOTE: THIS DEVELOPMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE 2019 CITY OF REDMOND STANDARD SPECIFICATION AND DETAILS.

APPROVED FOR CONSTRUCTION

FOR: DIRECTOR OF PUBLIC WORKS
CITY OF REDMOND

DATE: _____

PLAN CHK ENGR: _____

STORM: _____

UTILITY: _____

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SECTION, TOWNSHIP, RANGE:
NE 1/4 OF NW 1/4 OF SECTION 07,
TOWNSHIP 25 NORTH, RANGE 06
EAST, W.M.

PROJECT TEAM

REVIEWED BY: J.TAFLIN

DESIGNED BY: J.GREEN

SHEET NAME

GRADING AND DRAINAGE PLAN

SHEET NUMBER

C-2.0
19-XXXX

APPENDIX B

**OPERATION AND MAINTENANCE MANUAL
(TO BE PROVIDED IN THE NEXT SUBMITTAL OF THE STORM REPORT)**

APPENDIX C

WWHM INPUT AND OUTPUT

WWHM2012
PROJECT REPORT

General Model Information

Project Name: Lot 3-Detention Tank Sizing_190822
Site Name: Lot 3
Site Address: 188th and 76th
City: Redmond
Report Date: 8/22/2019
Gage: Seatac
Data Start: 1948/10/01
Data End: 2009/09/30
Timestep: 15 Minute
Precip Scale: 1.000
Version Date: 2018/10/10
Version: 4.2.16

POC Thresholds

Low Flow Threshold for POC1: 50 Percent of the 2 Year
High Flow Threshold for POC1: 50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass: No

GroundWater: No

Pervious Land Use acre
C, Forest, Flat 3.1

Pervious Total 3.1

Impervious Land Use acre

Impervious Total 0

Basin Total 3.1

Element Flows To:
Surface

Interflow

Groundwater

DRAFT

Mitigated Land Use

Basin 1

Bypass: No

GroundWater: No

Pervious Land Use acre
C, Lawn, Flat 0.21

Pervious Total 0.21

Impervious Land Use acre
PARKING FLAT 2.89

Impervious Total 2.89

Basin Total 3.1

Element Flows To:

Surface
Tank 1

Interflow
Tank 1

Groundwater

DRAFT

Mitigated Routing

Tank 1

Dimensions
Depth: 8 ft.
Tank Type: Circular
Diameter: 8 ft.
Length: 1350 ft.
Discharge Structure
Riser Height: 7.25 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.010 ft.
Notch Height: 2.750 ft.
Orifice 1 Diameter: 0.926 in. Elevation: 0 ft.
Element Flows To:
Outlet 1 Outlet 2

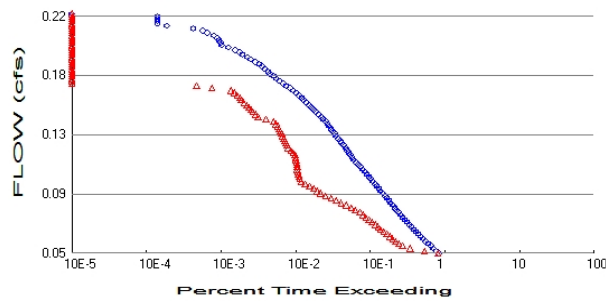
Tank Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.000	0.000	0.000	0.000
0.0889	0.052	0.003	0.006	0.000
0.1778	0.073	0.008	0.009	0.000
0.2667	0.089	0.015	0.012	0.000
0.3556	0.102	0.024	0.013	0.000
0.4444	0.113	0.034	0.015	0.000
0.5333	0.123	0.044	0.017	0.000
0.6222	0.132	0.056	0.018	0.000
0.7111	0.141	0.068	0.019	0.000
0.8000	0.148	0.081	0.020	0.000
0.8889	0.155	0.094	0.021	0.000
0.9778	0.162	0.108	0.023	0.000
1.0667	0.168	0.123	0.024	0.000
1.1556	0.174	0.138	0.025	0.000
1.2444	0.179	0.154	0.026	0.000
1.3333	0.184	0.170	0.026	0.000
1.4222	0.189	0.187	0.027	0.000
1.5111	0.194	0.204	0.028	0.000
1.6000	0.198	0.221	0.029	0.000
1.6889	0.202	0.239	0.030	0.000
1.7778	0.206	0.257	0.031	0.000
1.8667	0.209	0.276	0.031	0.000
1.9556	0.213	0.295	0.032	0.000
2.0444	0.216	0.314	0.033	0.000
2.1333	0.219	0.333	0.034	0.000
2.2222	0.222	0.353	0.034	0.000
2.3111	0.224	0.373	0.035	0.000
2.4000	0.227	0.393	0.036	0.000
2.4889	0.229	0.413	0.036	0.000
2.5778	0.231	0.433	0.037	0.000
2.6667	0.233	0.454	0.038	0.000
2.7556	0.235	0.475	0.038	0.000
2.8444	0.237	0.496	0.039	0.000
2.9333	0.239	0.517	0.039	0.000
3.0222	0.240	0.538	0.040	0.000

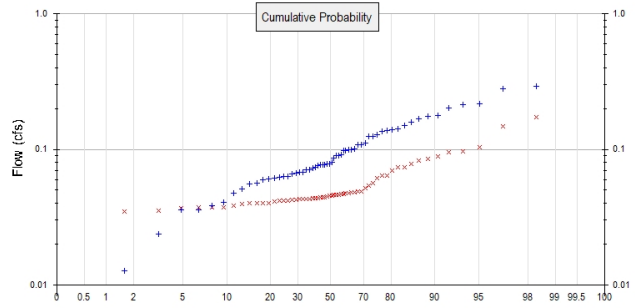
3.1111	0.241	0.560	0.041	0.000
3.2000	0.242	0.581	0.041	0.000
3.2889	0.244	0.603	0.042	0.000
3.3778	0.244	0.625	0.042	0.000
3.4667	0.245	0.647	0.043	0.000
3.5556	0.246	0.668	0.043	0.000
3.6444	0.247	0.690	0.044	0.000
3.7333	0.247	0.712	0.045	0.000
3.8222	0.247	0.734	0.045	0.000
3.9111	0.247	0.756	0.046	0.000
4.0000	0.247	0.778	0.046	0.000
4.0889	0.247	0.800	0.047	0.000
4.1778	0.247	0.823	0.047	0.000
4.2667	0.247	0.845	0.048	0.000
4.3556	0.247	0.866	0.048	0.000
4.4444	0.246	0.888	0.049	0.000
4.5333	0.245	0.910	0.049	0.000
4.6222	0.244	0.932	0.051	0.000
4.7111	0.244	0.954	0.053	0.000
4.8000	0.242	0.975	0.056	0.000
4.8889	0.241	0.997	0.058	0.000
4.9778	0.240	1.018	0.061	0.000
5.0667	0.239	1.040	0.065	0.000
5.1556	0.237	1.061	0.068	0.000
5.2444	0.235	1.082	0.071	0.000
5.3333	0.233	1.103	0.074	0.000
5.4222	0.231	1.123	0.078	0.000
5.5111	0.229	1.144	0.081	0.000
5.6000	0.227	1.164	0.085	0.000
5.6889	0.224	1.184	0.090	0.000
5.7778	0.222	1.204	0.094	0.000
5.8667	0.219	1.224	0.098	0.000
5.9556	0.216	1.243	0.118	0.000
6.0444	0.213	1.262	0.124	0.000
6.1333	0.209	1.281	0.131	0.000
6.2222	0.206	1.300	0.137	0.000
6.3111	0.202	1.318	0.144	0.000
6.4000	0.198	1.336	0.151	0.000
6.4889	0.194	1.353	0.157	0.000
6.5778	0.189	1.370	0.165	0.000
6.6667	0.184	1.387	0.172	0.000
6.7556	0.179	1.403	0.179	0.000
6.8444	0.174	1.419	0.187	0.000
6.9333	0.168	1.434	0.194	0.000
7.0222	0.162	1.449	0.202	0.000
7.1111	0.155	1.463	0.210	0.000
7.2000	0.148	1.476	0.218	0.000
7.2889	0.141	1.489	0.345	0.000
7.3778	0.132	1.501	0.947	0.000
7.4667	0.123	1.513	1.802	0.000
7.5556	0.113	1.523	2.789	0.000
7.6444	0.102	1.533	3.796	0.000
7.7333	0.089	1.541	4.710	0.000
7.8222	0.073	1.549	5.443	0.000
7.9111	0.052	1.554	5.955	0.000
8.0000	0.000	1.557	6.297	0.000
8.0889	0.000	0.000	6.717	0.000

Analysis Results

POC 1



+ Predeveloped x Mitigated



Predeveloped Landuse Totals for POC #1

Total Pervious Area: 3.1
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1

Total Pervious Area: 0.21
Total Impervious Area: 2.89

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.091143
5 year	0.143143
10 year	0.172612
25 year	0.203833
50 year	0.223152
100 year	0.239584

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.048892
5 year	0.067077
10 year	0.081357
25 year	0.102165
50 year	0.119829
100 year	0.139487

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.090	0.040
1950	0.112	0.046
1951	0.201	0.095
1952	0.063	0.037
1953	0.051	0.047
1954	0.079	0.042
1955	0.125	0.042
1956	0.100	0.061
1957	0.080	0.042
1958	0.091	0.045

1959	0.078	0.040
1960	0.136	0.073
1961	0.077	0.048
1962	0.048	0.037
1963	0.065	0.044
1964	0.086	0.048
1965	0.062	0.052
1966	0.059	0.043
1967	0.124	0.046
1968	0.077	0.043
1969	0.076	0.042
1970	0.062	0.045
1971	0.067	0.044
1972	0.149	0.078
1973	0.068	0.054
1974	0.074	0.044
1975	0.100	0.041
1976	0.072	0.043
1977	0.009	0.040
1978	0.063	0.046
1979	0.038	0.035
1980	0.142	0.097
1981	0.057	0.044
1982	0.109	0.056
1983	0.098	0.044
1984	0.060	0.037
1985	0.036	0.040
1986	0.158	0.047
1987	0.140	0.064
1988	0.055	0.042
1989	0.036	0.040
1990	0.292	0.070
1991	0.176	0.074
1992	0.068	0.046
1993	0.071	0.038
1994	0.024	0.035
1995	0.101	0.048
1996	0.214	0.089
1997	0.179	0.147
1998	0.040	0.039
1999	0.167	0.082
2000	0.070	0.047
2001	0.013	0.034
2002	0.077	0.049
2003	0.099	0.043
2004	0.128	0.104
2005	0.092	0.043
2006	0.108	0.064
2007	0.217	0.173
2008	0.280	0.085
2009	0.137	0.049

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.2922	0.1727
2	0.2798	0.1468
3	0.2169	0.1036

4	0.2136	0.0971
5	0.2007	0.0949
6	0.1785	0.0892
7	0.1759	0.0850
8	0.1674	0.0825
9	0.1580	0.0778
10	0.1495	0.0742
11	0.1416	0.0735
12	0.1397	0.0698
13	0.1374	0.0638
14	0.1357	0.0636
15	0.1276	0.0615
16	0.1253	0.0562
17	0.1239	0.0540
18	0.1116	0.0521
19	0.1089	0.0488
20	0.1079	0.0487
21	0.1013	0.0481
22	0.0998	0.0481
23	0.0997	0.0476
24	0.0985	0.0472
25	0.0976	0.0469
26	0.0915	0.0468
27	0.0906	0.0463
28	0.0895	0.0461
29	0.0861	0.0459
30	0.0804	0.0458
31	0.0785	0.0453
32	0.0777	0.0447
33	0.0773	0.0443
34	0.0772	0.0442
35	0.0766	0.0440
36	0.0756	0.0436
37	0.0737	0.0436
38	0.0722	0.0433
39	0.0707	0.0429
40	0.0705	0.0428
41	0.0679	0.0428
42	0.0678	0.0428
43	0.0667	0.0424
44	0.0654	0.0424
45	0.0633	0.0421
46	0.0632	0.0419
47	0.0624	0.0418
48	0.0616	0.0410
49	0.0603	0.0403
50	0.0593	0.0402
51	0.0566	0.0399
52	0.0551	0.0399
53	0.0512	0.0396
54	0.0476	0.0386
55	0.0404	0.0376
56	0.0383	0.0375
57	0.0360	0.0373
58	0.0358	0.0366
59	0.0237	0.0351
60	0.0126	0.0349
61	0.0086	0.0345

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0456	17547	17248	98	Pass
0.0474	16164	11355	70	Pass
0.0492	14968	7324	48	Pass
0.0510	13851	5775	41	Pass
0.0527	12814	5142	40	Pass
0.0545	11807	4639	39	Pass
0.0563	10900	4269	39	Pass
0.0581	10121	3953	39	Pass
0.0599	9383	3563	37	Pass
0.0617	8731	3243	37	Pass
0.0635	8147	2909	35	Pass
0.0653	7593	2710	35	Pass
0.0671	7060	2485	35	Pass
0.0689	6588	2252	34	Pass
0.0707	6145	2038	33	Pass
0.0725	5777	1866	32	Pass
0.0743	5431	1707	31	Pass
0.0761	5097	1542	30	Pass
0.0779	4808	1341	27	Pass
0.0797	4524	1189	26	Pass
0.0814	4252	1022	24	Pass
0.0832	4017	872	21	Pass
0.0850	3782	741	19	Pass
0.0868	3546	640	18	Pass
0.0886	3337	538	16	Pass
0.0904	3138	457	14	Pass
0.0922	2952	414	14	Pass
0.0940	2785	370	13	Pass
0.0958	2599	327	12	Pass
0.0976	2447	284	11	Pass
0.0994	2304	251	10	Pass
0.1012	2165	244	11	Pass
0.1030	2031	237	11	Pass
0.1048	1903	231	12	Pass
0.1066	1790	229	12	Pass
0.1084	1691	225	13	Pass
0.1101	1590	223	14	Pass
0.1119	1483	221	14	Pass
0.1137	1381	218	15	Pass
0.1155	1292	216	16	Pass
0.1173	1220	214	17	Pass
0.1191	1155	210	18	Pass
0.1209	1098	198	18	Pass
0.1227	1048	185	17	Pass
0.1245	998	169	16	Pass
0.1263	930	164	17	Pass
0.1281	884	159	17	Pass
0.1299	839	152	18	Pass
0.1317	790	148	18	Pass
0.1335	743	142	19	Pass
0.1353	713	138	19	Pass
0.1371	670	132	19	Pass
0.1388	633	128	20	Pass

0.1406	596	123	20	Pass
0.1424	566	115	20	Pass
0.1442	539	107	19	Pass
0.1460	497	85	17	Pass
0.1478	473	67	14	Pass
0.1496	434	62	14	Pass
0.1514	399	57	14	Pass
0.1532	370	54	14	Pass
0.1550	348	50	14	Pass
0.1568	323	47	14	Pass
0.1586	296	43	14	Pass
0.1604	273	40	14	Pass
0.1622	256	38	14	Pass
0.1640	235	35	14	Pass
0.1658	217	32	14	Pass
0.1675	197	29	14	Pass
0.1693	180	16	8	Pass
0.1711	158	10	6	Pass
0.1729	145	0	0	Pass
0.1747	129	0	0	Pass
0.1765	119	0	0	Pass
0.1783	109	0	0	Pass
0.1801	97	0	0	Pass
0.1819	91	0	0	Pass
0.1837	82	0	0	Pass
0.1855	76	0	0	Pass
0.1873	69	0	0	Pass
0.1891	61	0	0	Pass
0.1909	54	0	0	Pass
0.1927	48	0	0	Pass
0.1945	41	0	0	Pass
0.1962	38	0	0	Pass
0.1980	33	0	0	Pass
0.1998	27	0	0	Pass
0.2016	22	0	0	Pass
0.2034	21	0	0	Pass
0.2052	20	0	0	Pass
0.2070	19	0	0	Pass
0.2088	17	0	0	Pass
0.2106	14	0	0	Pass
0.2124	12	0	0	Pass
0.2142	9	0	0	Pass
0.2160	4	0	0	Pass
0.2178	3	0	0	Pass
0.2196	3	0	0	Pass
0.2214	3	0	0	Pass
0.2232	3	0	0	Pass

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DRAFT

APPENDIX D

**GEOTECHNICAL ENGINEERING EVALUATION BY NELSON GEOTECHNICAL
ASSOCIATES, INC. , DATED August 22, 2019**



**NELSON GEOTECHNICAL
ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERS & GEOLOGISTS

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August 22, 2019

Mr. Bob Power
Seacon, LLC
165 NE Juniper Street
Issaquah, Washington 98027

Geotechnical Engineering Evaluation
MV Transportation Facilities Expansion
Union Hill Lot 3 – 188th Avenue NE
Redmond, Washington
NGA Project No. 9696C19

Dear Mr. Power:

We are pleased to submit the attached report titled **“Geotechnical Engineering Evaluation – MV Transportation Facilities Expansion – Union Hill Lot 3 - 188th Avenue NE - Redmond, Washington.”** This report summarizes the existing surface and subsurface conditions within the site and provides recommendations for the proposed site development. Our services were completed in general accordance with the proposal signed by you on June 27, 2019.

The site is located along the western side of 188th Avenue NE immediately east of the properties located at 7555 NE 76th Street and 18690 NE 73rd Street. The parcel number for the property is 072506-9141. The site is a roughly rectangular-shaped parcel covering approximately 4.13 acres. The site is currently undeveloped. We understand that the proposed development plans include construction of a parking lot for shuttles and busses throughout the site with associated utility improvements. Vertical relief from adjacent roadways is to be supported mainly by grading, although a keystone block retaining wall less than 4 feet in height may be necessary within the northwestern portion of the site. The proposed finished floor elevation of the parking lot is approximately 90 ± 5 feet. The lowest portion of the site along the eastern property boundary is approximately 85 feet. Current grading plans provided for the site show excavations to bring the site to the proposed elevations. Based on groundwater elevation data and previous experience with projects in the vicinity of the site, we do not anticipate the need for dewatering of the site during construction. Specific stormwater plans were also not available at the time this report was prepared. However, we anticipate that due to the relatively silty nature and thickness of the fill soils that underlie the surface of the site that infiltration is likely not feasible and that stormwater will likely be directed to an appropriate stormwater collection system within the site.

We explored the subsurface soil and groundwater conditions on August 1, 2019 with seven trackhoe-excavated test pits. In general, the test pits exposed silty sand with gravel with varying amounts of debris to the depths explored. We interpreted the soils to be undocumented fill soils that were placed here as a part of previous grading and filling performed within the property. Review of a previously prepared geotechnical report for nearby properties indicated that the property to the east was explored with nine drilled borings extending to depths in the range of 26.5 to 46.5 feet below the existing ground surface.

These borings generally encountered undocumented fill soils consisting of lean clay, clayey sand, sandy silt, silty sand, and silty gravel with varying amounts of cobbles, boulders, organics, and wood debris within the upper portion of the borings. Seven of the nine borings were completed within the fill soils. Within the two northern borings, sands and gravels interpreted to be native recessional outwash were encountered at approximately 40 feet below the existing ground surface or an elevation of 45 feet.

We have concluded that the site is generally compatible with the planned parking lot development from a geotechnical standpoint. We understand that the proposed parking lot will likely be supported by 3H:1V graded slopes and short, keystone block retaining walls less than 4 feet in height. We have provided recommendations for pavement subgrade and pavement sections in the following report, as well as designs for the planned Keystone walls.

It has been a pleasure to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

A handwritten signature in black ink, appearing to read 'K. Shawish', with a stylized flourish extending to the right.

Khaled M. Shawish, PE
Principal

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FIGURES

Figure 1 – Vicinity Map

Figure 2 – Schematic Site Plan

Figure 3 – Soil Classification Chart

Figures 4 and 5 – Test Pit Logs

Figure 6 – Keystone Block Wall Detail

Appendix A – Keystone Block Retaining Wall Calculations

**Geotechnical Engineering Evaluation
MV Transportation Facilities Expansion
Union Hill Lot 3 – 188th Avenue NE
Redmond, Washington**

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the MV Transportation Facilities Expansion project in Redmond, Washington. The project site is known as Lot 3 Union Hill, and is located southwest of the intersection of NE 76th Street and 188th Avenue NE as shown on the Vicinity Map in Figure 1. The purpose of this study is to explore and characterize the site's surface and subsurface conditions and to provide geotechnical recommendations for the proposed site development.

We understand that the proposed development plans include construction of a parking lot for shuttles and busses throughout the site with associated utility improvements. Vertical relief from adjacent roadways is to be supported mainly by grading, although a keystone block retaining wall less than 4 feet in height may be necessary within the northwestern portion of the site. The proposed finished elevation of the parking lot is approximately 90 ± 5 feet. The lowest portion of the site along the eastern property boundary is approximately 85 feet. Current grading plans provided for the site show excavations to bring the site to the proposed elevations. Based on groundwater elevation data and previous experience with projects in the vicinity of the site, we do not anticipate the need for dewatering of the site during construction. Specific stormwater plans were also not available at the time this report was prepared. However, we anticipate that due to the relatively silty nature and thickness of the fill soils that underlie the surface of the site that infiltration is not feasible and that stormwater will likely be directed to an appropriate stormwater collection system within the site. The existing and proposed site conditions are shown on the Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions, and provide general recommendations for site development. Specifically, our scope of services included the following:

1. A review of available soil and geologic maps of the area, available plans, and any available geotechnical reports for the property.
2. Exploring the subsurface soil and groundwater conditions within the site and vicinity of the proposed retaining wall alignments with 15- to 20-foot deep excavated test pits. Excavation services were provided by the Client.
3. Performing laboratory classification and analyses on soil samples obtained from the explorations, as necessary.
4. Providing recommendations for site grading and earthwork, including structural fill materials and construction standards.
5. Providing recommendations for temporary and permanent slopes.

6. Providing recommendations for pavement subgrade.
7. Providing recommendations for site drainage and erosion control.
8. Providing recommendations for retaining wall design and construction.
9. Providing calculations and engineering details for planned fill and retaining walls.
10. Documenting the results of our conclusions and recommendations in a written geotechnical engineering report.

SITE CONDITIONS

Surface Conditions

The site is located along the western side of 188th Avenue NE immediately east of the properties located at 7555 NE 76th Street and 18690 NE 73rd Street. The parcel number for the property is 072506-9141. The site is a roughly rectangular-shaped parcel covering approximately 4.13 acres. The site is currently undeveloped. Large soil stockpiles from previous grading activities are located within the southern central portion of the property.

Approximately 2 Horizontal to 1 Vertical (2H:1V) slopes are also located on the southern and northern sides of the site, supporting roughly 6 to 11 feet of vertical relief from adjacent roadway areas to the upland portions of the site, respectively. On the eastern portion of the site, 3H:1V slopes support relief of up to 7 feet from 188th Avenue NE. Based on our experience with the neighboring sites to the west, we understand that the soil stockpiles and graded slopes were created during past grading and filling activities within the site. Elevations within the site range from 73 feet within the lower northern portion of the site to 111 feet at the top of the soil stockpile within the northwestern portion of the property. An approximate elevation contour of 94 feet is located along the toe of the soil stockpiles and the top of most of the graded slopes within the northern, eastern, and southern perimeter of the property. Shallow ponding surface water was observed in the northeastern, upland portion of the site during our site visit on August 1, 2019. The water is associated with a sediment settlement pond. We did not observe signs of recent soil movement or groundwater seepage on the site fill slopes.

Subsurface Conditions

Geology: The geologic units for this area are shown on the Geologic Map of the Redmond Quadrangle, King County, Washington, by James P. Minard and Derek B. Booth (US Geological Survey, 1988). The site is mapped as Redmond Delta (Qvrd). These deposits are described as sand with gravel soils. In general, our explorations along with the previous exploration performed within the site encountered silty sand with gravel that we interpreted as previously placed structural fill during previous grading activities.

Explorations: The subsurface conditions within the site were explored on August 1, 2019 by excavating seven test pit explorations throughout the property that extended to depths of approximately 11.5 to 15.0 feet below the existing ground surface. The approximate locations of our explorations are shown on the Schematic Site Plan in Figure 2. A geologist from NGA was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the test pits.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 3. The test pit logs are attached to this report and are presented as Figures 4 and 5. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the test pit logs should be reviewed.

Test pits generally encountered a surficial layer brown, silty, fine to medium sand with gravel, organics, and varying amounts of anthropogenic debris, including brick, plastic, and processed wood. This material extended to depths of 5.5 to 8 feet below the existing surface and was encountered in a loose to medium dense condition. We interpreted this deposit to be recent undocumented fill. Underlying the recent fill, explorations recovered silt with fine sand and gravel, cobbles, boulders, and organic debris in a loose to medium dense condition. We interpreted this material to be undocumented fill associated with historic site grading after completion of surface mining operations. In Test Pit 5 on the northeastern portion of the site, we encountered dark brown to black silty, fine to coarse sand with gravel and anthropogenic debris to a depth of 15 feet below the surface, where the exploration was terminated. We interpreted this soil to be fill of an abandoned temporary sediment control pond on the site.

Deeper subsurface boring explorations were performed within adjacent property to the northwestern portion of the site by Kleinfelder in 2015. This exploration program consisted of nine drilled borings extending down to depths of 26.5 to 46.5 feet below the existing ground surface. These borings generally encountered undocumented fill soils consisting of lean clay, clayey sand, sandy silt, silty sand, and silty gravel with varying amounts of cobbles, boulders, organics, and wood debris within the upper portion of the borings. Seven of the nine borings were completed within the fill soils. Within the two northern borings, sands and gravels interpreted to be native recessional outwash were encountered at approximately 40 feet below the existing ground surface or an elevation of 45 feet. These two borings were terminated within the native recessional outwash soils.

Hydrogeologic Conditions

Groundwater seepage was encountered in the explorations where historic sediment settlement ponds had been present, specifically in Test Pits 5 and 6 at depths of 10 and 5.5 feet below the surface, respectively. We did not observe groundwater emitting from the site slopes. The groundwater table on this site is interpreted to be well below any proposed modifications to the site. Any near-surface groundwater encountered on this site, such as that which was encountered in explorations would be interpreted as a perched water condition. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of underlying, less permeable soils. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of precipitation. We would expect the amount of perched water to decrease during drier times of the year and increase during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

The 2018 International Building Code (IBC) seismic design section provides a basis for seismic design of structures. Since medium dense/medium stiff or better glacial soils were encountered underlying the site at depth, the site conditions best fit the IBC description for Site Class D. Table 1 below provides seismic design parameters for the site that are in conformance with the 2015 IBC, which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1 – 2015 IBC Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g) S_s	Spectral Acceleration at 1.0 sec. (g) S_1	Site Coefficients		Design Spectral Response Parameters (g)	
			F_a	F_v	S_{DS}	S_{D1}
D	1.249	0.478	1.001	1.522	0.833	0.485

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2008 data) for the project latitude and longitude.

Hazards associated with seismic activity include liquefaction potential and amplification of ground motion by soft deposits. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. The particle size distribution of materials in the undocumented fills on the site result in a low potential for liquefaction at the site. The proposed parking lot should not experience detrimental effects of amplification of ground motion if recommendations for subgrade improvements are followed as specified in this report.

The loose surficial materials and undocumented fill soils on the site slopes currently have the potential for shallow sloughing failures during seismic events. Such events should not affect the proposed parking lot, provided the site is graded and designed in accordance with the recommendations presented in this report.

Erosion Hazard

The criteria used for determination of the erosion hazard for affected areas include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey of King County Area, Washington, by the Soil Conservation Service (SCS), was reviewed to determine the erosion hazard of the on-site soils. The surface soils for this site are mapped as Everett very gravelly sandy loam, 8 to 15 percent slopes. The erosion hazards for these soil types is listed as slight. We anticipate that the existing fill soils within the site have a moderate erosion hazard. A soil management plan for erosion at the site has been submitted under a separate cover. We have included general recommendations for erosion control in the **Erosion Control** subsection of this report.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the site is compatible with the planned parking lot development from a geotechnical standpoint. Our explorations and review of the site conditions indicated that the site is underlain by as much as 50 feet of previously placed fill soils. This fill is generally in a loose to medium dense condition. We understand that the proposed development will consist of a parking lot with associated utility improvements. It is also our understanding that up to 4-foot tall reinforced-earth retaining walls will be constructed along the northern and northwestern portions of the property to bring the site up to the proposed finished grade elevations. In our opinion, a geo-grid reinforced Keystone block retaining wall is suitable for the site conditions along northwestern portion of the site to support the upper parking lot area.

Our explorations and review of the previous explorations within the site generally indicated that the planned 4-foot tall wall areas and site slopes are generally underlain by previously placed fill soils. Medium dense or better fill soils should provide adequate support for the planned retaining walls. Wall foundations should be overexcavated by a minimum of one foot and backfilled with 2- to 4-inch rock spalls. We recommend that level benches be graded into the site slopes to allow for placement of the wall components and fill to be retained by the walls. NGA should be retained to review project plans prior to construction and should be retained to observe wall construction to verify wall installation is performed in accordance with the plans and our recommendations.

Subgrade preparation in the pavement areas should consist of over-excavating by a minimum of one foot, placement of a reinforcing geogrid, and replacement with crushed rock. The crushed rock should consist of a minimum 12 inches of clean 1¼-inch angular crushed rock and be compacted to structural fill specifications prior to placing pavement. We recommend that the exposed subgrade be compacted to a non-yielding condition using a heavy vibratory drum roller prior to placing the geogrid and crushed rock. The resulting surface should be proof-rolled using a loaded dump truck. Areas observed to pump or weave during the proof-roll test should be over-excavated and replaced with rock spalls. Once a stable subgrade is achieved, the geogrid and crushed rock fill could be placed over the prepared subgrade.

Underground utilities should be planned and implemented as to not interfere with geogrid placement. All utilities should be in place prior to placing geogrid. Once placed, the geogrid should never be cut or disturbed in any way. Underground utilities should be supported on a minimum of one foot of pit run. Some of the on-site soils may be suitable for use as utility trench backfill but that will be highly dependent on material makeup. This can be determined during construction under the supervision of NGA.

The soils that are expected to be encountered during site development are considered highly moisture-sensitive and will disturb in wet conditions. We recommend that the site be developed during the dry season. If construction takes place during the rainy months, the site soils may disturb and become extremely difficult to work. Also, if construction takes place during the wet season, additional expenses and delays should be expected. Additional expenses could include the need for placing a blanket of rock spalls on exposed subgrades, construction traffic areas, and pavement areas prior to placing structural fill. NGA should be retained to determine if some of the on-site soils could be used as structural fill material during construction.

All grading operations and drainage improvements planned as part of this project should be planned and completed in a manner that enhances the stability of the site, not reduces it. Any excavation spoils generated during site improvements should not be stockpiled on site but rather promptly hauled away. Also, all current and future runoff generated within the site should be collected and routed to a permanent discharge location at the bottom of the slope, or to an approved drainage system. Under no circumstances should water be allowed to concentrate or flow uncontrollably over the walls or slope. The vegetation cover on the slope should be evaluated for compatibility with desired slope stability conditions, and a vegetation management plan should be devised to enhance slope stability.

Erosion Control and Slope Protection

The on-site soils have a moderate potential for water erosion when exposed, but the actual erosion potential will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped areas. Silt fences or straw bales could be erected to prevent muddy water from flowing off the site. Stockpiles should be covered with plastic sheeting. Disturbed areas should be planted as soon as practical and the vegetation should be maintained until it is established. The erosion potential for areas not stripped of vegetation should be low. Final grading should incorporate permanent erosion control measures and should be designed to route stormwater runoff to appropriate discharge locations away from the structures and sloping ground.

Temporary and Permanent Slopes

Cuts associated with over-excavation of utility areas may be used for this project. Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open and the presence of surface or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since they are continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered.

The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 2 Horizontal to 1 Vertical (2H:1V) if worker access is necessary. If significant groundwater seepage is encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. These erosion protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations.

Permanent cut and fill slopes should be no steeper than 3H:1V, in accordance with City of Redmond regulations. However, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be planted and the vegetative cover should be maintained until it is established. We should review plans and visit the site to evaluate excavations for this project.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of overexcavating the pavement subgrade by a minimum of 12 inches as discussed in this report, and replacing the overexcavation with geogrid-reinforced structural fill. The subgrade should be proof-rolled and repaired to achieve a non-yielding state prior to placing geogrid. Level benches should be created for retaining wall and associated backfill placement. Retaining wall foundations should be supported on a minimum of one foot of rock spalls.

If, after site stripping, the ground surface should appear to be loose, it should be compacted to a non-yielding condition and then proof-rolled with a heavy rubber-tired piece of equipment. Areas observed to pump or weave during the proof-roll test should be overexcavated and replaced with rock spalls. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed, and the exposed subgrades should be maintained in a semi-dry condition.

If wet conditions are encountered, alternative site stripping and grading techniques might be necessary. These could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and covering exposed subgrade with a layer of crushed rock for protection. If wet conditions are encountered or construction is attempted in wet weather, the subgrade should not be compacted as this could cause further subgrade disturbance. In wet conditions it may be necessary to cover the exposed subgrade with a layer of crushed rock as soon as it is exposed to protect the moisture sensitive soils from disturbance by machine or foot traffic during construction. The prepared subgrade should be protected from construction traffic and surface water should be diverted around prepared subgrade.

The site soils are considered to be moisture-sensitive and can disturb easily when wet. We recommend that construction take place during the drier summer months if possible. However, if construction takes place during the wet season, additional expenses and delays should be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls on exposed subgrades, construction traffic areas, and paved areas prior to placing structural fill. The successful use of on-site soils as structural fill will be very difficult, but will depend on the moisture content of the soil at the time of construction. NGA should be retained to determine if any of the on-site soils could be used as structural fill material prior to construction.

Keystone Block Retaining Wall

The total height of the new block walls will vary somewhat, but we understand that they will generally be up to approximately four feet in exposed heights. We have provided a wall design for an up to 6-foot-tall total retaining wall with geogrid-reinforced fill utilizing 21.5-inch Standard Keystone blocks. The retained fill zone should consist of imported granular material compacted to structural fill specifications. The drainage system, as indicated on the detail, should be installed along the base of the blocks and behind the wall facing.

Traffic surcharge loads of 250 psf were included in the overall Keystone Block Wall design to account for heavy-traffic loading. The surcharge load was applied to the Keystone Block wall design and setback 5.0 feet back from the face of the Keystone block wall. A geogrid-reinforced wall detail and construction notes are shown in Figure 6. Please refer to Appendix A for detailed Keystone Retaining wall calculations.

The block facing should consist of 21.5-inch Standard Keystone blocks. The block facing should be placed on a minimum of 6-inch thick crushed rock leveling pad placed over a minimum of one foot of 2- to 4-inch rock spalls. The subgrade should be level and compacted to a non-yielding condition before placing the blocks or backfill.

A drainage blanket of 12 inches of free-draining $\frac{3}{4}$ -inch clean crushed rock should be placed between the blocks and the retained fill zone. The block cavities should also be filled with the crushed rock. A rigid, 6-inch perforated drainpipe embedded in a minimum of one foot of drain rock and wrapped in a filter fabric should be placed at the bottom of the drainage blanket. The drain should be sloped to drain into an approved system.

Mirafi 5XT geogrid (or equivalent) is recommended to be used in the geogrid-reinforced fill wall design. The geogrid should be cut to the recommended lengths, attached to the blocks as recommended by the manufacturer, and extended back into the reinforced fill zone. The grid should be pulled tight before the fill is placed over the geogrid. Care should be taken to not damage the geogrid by operating construction equipment on the exposed grid, or by allowing large rocks to be placed directly on the grid.

All fill placed in the retained fill zone behind the retaining walls should be placed in accordance with the recommendations laid out in the **Structural Fill** subsection of this report.

If groundwater seepage is encountered or if excessive rainfall occurs during construction of specific aspects, we recommend that the contractor slope the bottom of the excavations and direct the water to ditches and small sump pits. The collected water can then be directed to a suitable discharge point.

Structural Fill

General: Fill placed behind retaining walls and underneath pavement areas should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection of this report, prior to beginning fill placement. Sloping areas on this site should be benched for fill placement. The benches should be level and be a minimum of six feet in width.

Materials: Structural fill should consist of a good quality, all-weather granular soil, free of organics and other deleterious material and be well graded to a maximum size of about three inches. Fill material should contain no more than five-percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). The use of the on-site soils as structural fill is not recommended. NGA should be retained during construction to determine if any of the on-site soils could be used as structural fill.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All backfilling should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure. The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction.

Pavements

Pavement subgrade preparation, and structural fill placement should be completed as recommended in the **Site Preparation and Grading** and **Structural Fill** subsections of this report. We recommend that a minimum of 12-inches of clean 1¼-inch crushed rock be placed below the pavement section, underlain by a Tensar TX 160 geogrid, or equivalent. The existing soil should be over excavated and replaced with crushed rock fill prior to placing new pavement section. The pavement subgrade should be heavily compacted and proof-rolled with a heavy, rubber-tired piece of equipment, to identify soft or yielding areas that require repair prior to placing geogrid and crushed rock. We should be retained to observe the proof-rolling and recommend subgrade repairs prior to placement of the geogrid and crushed rock.

We recommend the pavement section consist of the eight inches of crushed rock base-course, overlain by 4.0 inches of PG 64-22 Class ½-inch Hot Mix Asphalt (HMA). The base-course layer is in addition to the 1¼-inch crushed rock.

Utilities

We recommend that underground utilities be underlain with a minimum 12 inches of pit run prior to backfilling the trench with on-site or imported material meeting structural fill requirements. Trenches within settlement sensitive areas should be compacted to 95% of the modified proctor as described in the **Structural Fill** subsection of this report. Trenches located in non-structural areas should be compacted to a minimum 90% of the maximum dry density. When excessively soft and/or debris-laden soils are encountered within utility trench excavations, such soils should be overexcavated and replaced with crushed rock. All underground utilities need to be in place prior to geogrid placement.

Site Drainage

Surface Drainage: The finished ground surface should be graded such that stormwater is directed to an appropriate stormwater collection system. Surface water should be collected by permanent catch basins and drain lines, and be discharged into an appropriate discharge system.

Subsurface Drainage: If perched groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out of the excavation and routed into an appropriate discharge point.

We recommend the use of drains behind retaining walls. The drains should consist of a minimum four-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material, such as washed rock, wrapped in a filter fabric. We recommend that an 18-inch-wide zone of clean (less than three-percent fines), granular material be placed along the back of subsurface walls above the drain. Pea gravel is an acceptable drain material, or drainage composite may be used instead. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of backfill should consist of impermeable soil placed over plastic sheeting or building paper to minimize the migration of surface water or fines into the footing drain. Footing drains should discharge into tightlines leading to an appropriate collection and discharge point with convenient cleanouts to prolong the useful life of the drains.

USE OF THIS REPORT

NGA has prepared this report for Mr. Bob Power and his agents, for use in the planning and design of the development planned on this site only. The scope of our work does not include services related to construction safety precautions and our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. There are possible variations in subsurface conditions between the explorations and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule.

We recommend that NGA be retained to review project plans and consult with the design team during final design. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

O-O-O

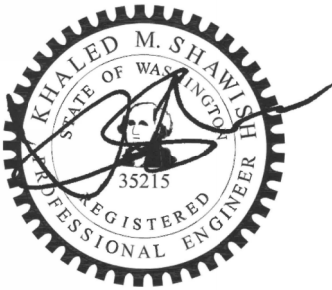
It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Carston T. Curd

Carston T. Curd, GIT
Project Geologist



Khaled M. Shawish, PE
Principal

CTC:KMS:dy

Attachments: Six Figures
Appendix A – Keystone Block Retaining Wall Calculations



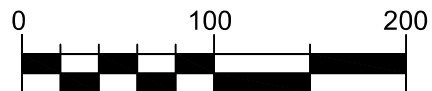
Project Number 9696C19	MV Transportation Facilities Expansion Vicinity Map	 <p>NELSON GEOTECHNICAL ASSOCIATES, INC. GEOTECHNICAL ENGINEERS & GEOLOGISTS Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510 www.nelsongeotech.com East Wenatchee Office 5526 Industry Lane, #2 East Wenatchee, WA 98802 (509) 665-7696 / Fax: 665-7692</p>	No.	Date	Revision	By	CK
Figure 1			1	8/2/19	Original	DPN	ABR

Site Plan



LEGEND

- . - Property line
- TP-1
 Number and approximate location of test pit



Scale: 1 inch = 100 feet

Reference: Site Plan based on an undated plan titled "Topo Plot - Lot 3, Union Hill Corporate Center," prepared by DOWL.

Project Number 9696C19	MV Transportation Facilities Expansion Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC. GEOTECHNICAL ENGINEERS & GEOLOGISTS <small>Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510 www.nelsongeotech.com</small> <small>East Wenatchee Office 5526 Industry Lane, #2 East Wenatchee, WA 98802 (509) 665-7696 / Fax: 665-7692</small>	No.	Date	Revision	By	CK
Figure 2			1	8/2/19	Original	DPN	ABR

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME	
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL	
			GP	POORLY-GRADED GRAVEL	
		GRAVEL WITH FINES	GM	SILTY GRAVEL	
			GC	CLAYEY GRAVEL	
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND	
			SP	POORLY GRADED SAND	
		SAND WITH FINES	SM	SILTY SAND	
			SC	CLAYEY SAND	
	FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
				CL	CLAY
ORGANIC			OL	ORGANIC SILT, ORGANIC CLAY	
SILT AND CLAY LIQUID LIMIT 50 % OR MORE		INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT	
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY	
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT	
HIGHLY ORGANIC SOILS			PT	PEAT	

NOTES:

- 1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.
- 2) Soil classification using laboratory tests is based on ASTM D 2488-93.
- 3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number 9696C19	MV Transportation Facilities Expansion Soil Classification Chart	 NELSON GEOTECHNICAL ASSOCIATES, INC. GEOTECHNICAL ENGINEERS & GEOLOGISTS <small>Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510 www.nelsongeotech.com</small> <small>East Wenatchee Office 5526 Industry Lane, #2 East Wenatchee, WA 98802 (509) 665-7696 / Fax: 665-7692</small>	No.	Date	Revision	By	CK
			1	8/2/19	Original	DPN	ABR

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 8.0		LIGHT BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, PLASTIC DEBRIS, ORGANICS, AND TRACE COBBLES (LOOSE TO MEDIUM DENSE, DRY TO MOIST) (RECENT FILL)
8.0 – 12.0		DARK BROWN TO DARK GRAY, SILTY FINE SAND WITH GRAVEL, ORGANICS, AND WOOD DEBRIS (LOOSE TO MEDIUM DENSE, MOIST) (HISTORIC FILL) SAMPLE WAS COLLECTED AT 11.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 12.0 FEET ON 8/1/2019
TEST PIT TWO		
0.0 – 7.0		LIGHT BROWN TO BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, CONCRETE DEBRIS, WOOD DEBRIS, AND PLASTIC SCRAPS (MEDIUM DENSE, DRY TO MOIST) (RECENT FILL)
7.0 – 13.0		GRAY TO DARK BROWN, SILT WITH FINE SAND TO SILTY FINE SAND WITH GRAVEL, COBBLES, ORGANICS, TRACE WOOD DEBRIS, AND BOULDERS (LOOSE TO MEDIUM DENSE, MOIST) (HISTORIC FILL) SAMPLE WAS COLLECTED AT 13.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 13.0 FEET ON 8/1/2019
TEST PIT THREE		
0.0 – 6.0		LIGHT TO DARK BROWN, SILTY FINE TO MEDIUM SAND WITH DRAIN ROCK POCKETS, BRICK AND CONCRETE RUBBLE, AND TRACE WOOD DEBRIS (LOOSE TO MEDIUM DENSE, DRY TO MOIST) (RECENT FILL)
6.0 – 14.0		GRAY, SILT WITH FINE SAND TO SILTY FINE TO MEDIUM SAND WITH DARK BROWN ORGANIC POCKETS, TRACE WOOD DEBRIS, PLASTIC SCRAPS, AND ASPHALT CHUNKS (LOOSE TO MEDIUM DENSE, MOIST) (HISTORIC FILL) SAMPLE WAS COLLECTED AT 14.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 14.0 FEET ON 8/1/2019
TEST PIT FOUR		
0.0 – 7.5		DARK BROWN TO BLACK, SILTY GRAVEL WITH FINE TO COARSE SAND, ASPHALT GRINDINGS, WOOD DEBRIS, ORGANICS, BRICK AND CONCRETE FRAGMENTS, TRACE METAL SCRAPS AND PLASTIC (MEDIUM DENSE TO DENSE, DRY TO MOIST) (RECENT FILL)
7.5 – 11.5		GRAY TO GRAY-BLUE, SILT WITH FINE SAND TO SILTY FINE SAND WITH GRAVEL, WOOD DEBRIS, CONCRETE RUBBLE, BRICK DEBRIS, PLASTIC, AND METAL SCRAPS (LOOSE TO MEDIUM DENSE, MOIST TO WET) (HISTORIC FILL) SAMPLES WERE NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 11.5 FEET ON 8/1/2019

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT FIVE		
0.0 – 15.0		DARK BROWN TO BLACK, SILTY FINE TO COARSE SAND WITH GRAVEL, WOOD DEBRIS, CONCRETE RUBBLE, BRICK FRAGMENTS, PLASTIC AND METAL SCRAPS (LOOSE, MOIST TO WET) (ABANDONED POND FILL) SAMPLES WERE NOT COLLECTED GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 10.0 FEET TEST PIT CAVING WAS ENCOUNTERED FROM 3.0 TO 15.0 FEET TEST PIT WAS COMPLETED AT 15.0 FEET ON 8/1/2019
TEST PIT SIX		
0.0 – 5.5		DARK BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ORGANICS, WOOD DEBRIS, AND DRAIN ROCK (LOOSE, MOIST) (RECENT FILL)
5.5 – 11.5		GRAY, SILT WITH FINE SAND TO SILTY FINE TO MEDIUM SAND WITH GRAVEL, TRACE ORGANICS, AND WOOD DEBRIS (MEDIUM DENSE, MOIST) (HISTORIC FILL) SAMPLE WAS COLLECTED AT 10.5 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.5 FEET TEST PIT CAVING WAS ENCOUNTERED FROM 3.0 TO 6.0 FEET TEST PIT WAS COMPLETED AT 11.5 FEET ON 8/1/2019
TEST PIT SEVEN		
0.0 – 6.0		GRAY TO DARK BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL AND ORGANICS (LOOSE, MOIST TO WET) (RECENT FILL)
6.0 – 11.5		DARK BROWN TO BLACK, SILTY GRAVEL WITH FINE TO COARSE SAND, ASPHALT GRINDINGS, BRICK, WOOD, AND CONCRETE DEBRIS (MEDIUM DENSE TO DENSE, MOIST) (HISTORIC FILL) SAMPLE WAS NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 11.5 FEET ON 8/1/2019

SPECIFICATIONS FOR REINFORCED WALL

General

1. The contractor shall have an approved set of plans and specifications on site at all times during the construction of the wall. The wall layout is the responsibility of the contractor.
2. Nelson Geotechnical Associates (NGA) should observe and monitor the construction of the wall.
3. Mirafi geogrid 5XT or equivalent shall be used for this project. All geogrid and facing materials shall be approved by NGA prior to installation.
4. The contractor may use longer geogrid lengths than the design sections for ease of construction. The geogrid lengths may not be shorter unless approved by NGA.

Subgrade Preparation

1. The ground should be prepared by removing surficial organics and loose soil to expose competent native soils as approved by the NGA.
2. A generally level bench with a minimum width equal to the design length of the geogrid is required for placement of the reinforced fill.
3. The excavation shall be cleaned of all excess material and protected, as necessary, from construction traffic to maintain the integrity of the subgrade.
4. The base of the excavation should be deep enough to satisfy a minimum embedment of 1.0 feet.

Geogrid Placement

1. The reinforcement shall be rolled out, cut to length, and laid at the proper elevation, location, and orientation. Orientation of the reinforcement is of extreme importance since geogrids vary in strength with roll direction. The contractor shall be responsible for the correct orientation.
2. Geogrid shall be placed at the location and elevations shown on the plans. The geogrid length is measured from the back of the block.
3. Prior to placing the fill, the geogrid shall be pulled to remove the slack and stretched by hand until taut and free of wrinkles.

Fill Placement

1. Structural fill, consisting of granular import soils, would then be placed upon the subgrade and geogrid. If larger rock is used in the fill, additional layers of geogrid may need to be used in the reinforcement. The contractor shall prevent damage to the geogrid by placing the first lift of structural fill with at least a 1-foot thickness. NGA shall approve the material placed in the reinforced zone, before placement.
2. Structural fill should have parameters equal to or better than those stated for the reinforced wall fill below with less than 15 percent passing the number 200 sieve. NGA may allow a higher silt content based on review of the wall design and proposed fill parameters.
3. Soil density tests should be performed as designated by the geotechnical engineer.
4. Fill soils in the wall area shall be compacted to at least 95 percent of the Maximum Dry Density (MDD) as determined by ASTM D-1557.
5. The soil shall be placed in relatively uniform horizontal lifts, not exceeding 10 or 12 inches in thickness. The lift thickness shall not exceed the manufacturer's recommended depth for the compactive device used on the project.

Drainage

1. A specific drainage system is shown on the plans. Alternative drains can be used based on conditions found in the field and the material used within the reinforced zone. Changes to the drainage system should be approved by NGA prior to placement.
2. A drainage blanket 12 inches in width should be installed directly behind the Keystone block facing and shall consist of 3/4-inch clean crushed rock. All of the drainage materials shall have a fines content no greater than 5 percent passing the number 200 sieve. A 6-inch rigid perforated pipe embedded in a minimum of one foot of pea gravel or washed rock and wrapped with filter fabric should be installed at the bottom of the drainage blanket.
3. Surface water shall not be allowed to pond in or near the reinforced fill zone during or after construction.
4. Suitable clean-outs should be installed every 50 feet for future maintenance.

Design Parameters

Reinforced Wall Fill: 34 degrees, 0 PSF, 125 PCF
Retained Backfill: 32 degrees, 0 PSF, 120 PCF
Foundation Soil: 32 degrees, 0 PSF, 120 PCF

External Stability of Wall

Minimum Factor of Safety against Base Sliding: 1.5
Minimum Factor of Safety against Overturning: 2.0
Minimum Factor of Safety against Bearing Capacity: 2.0

Internal Stability of Wall

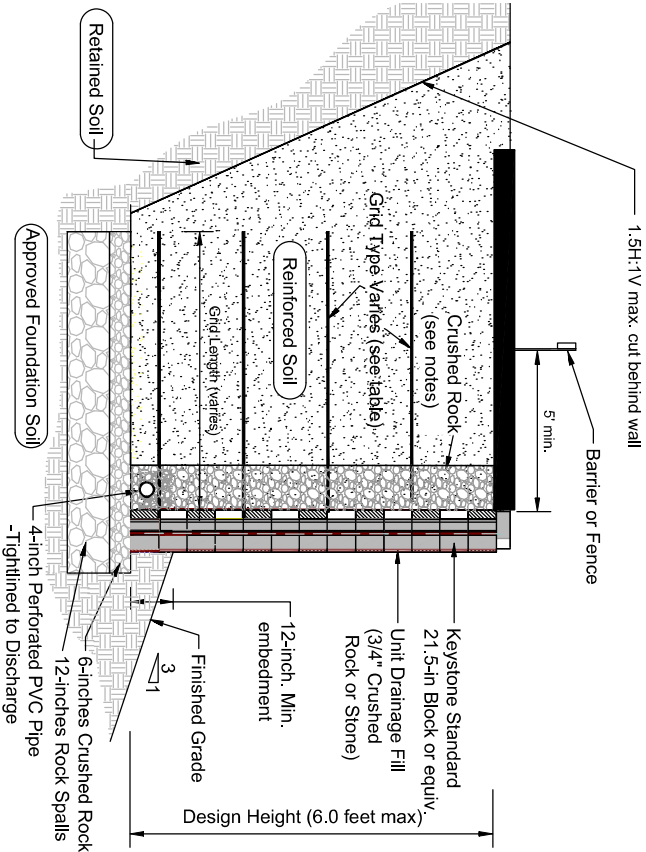
Minimum Factor of Safety on Geogrid Strength: 1.5
Minimum Factor of Safety on Geogrid Pullout: 1.5
Soil-Geogrid Interaction Coefficient: 1.0
Percent Coverage of Geogrid: 100 Percent

External Loading

250 PSF Traffic Loading located 5 ft from back of wall

Inspection

Wall construction shall be periodically inspected under the direction of NGA.



Wall Height (feet)	Number of Geogrid Layers	Geogrid Length (feet)	Geogrid Height Above Leveling Pad / Geogrid Type (feet)
4	2	5.0	0.67 5XT* 2.67 5XT
6	3	7.0	0.67 5XT 2.67 5XT 4.67 5XT

*Mirafi 5XT Geogrid (or equivalent)



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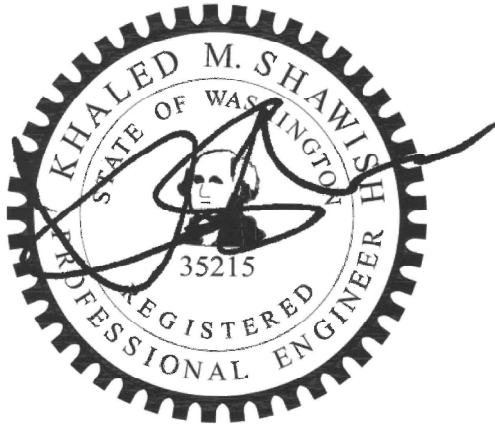
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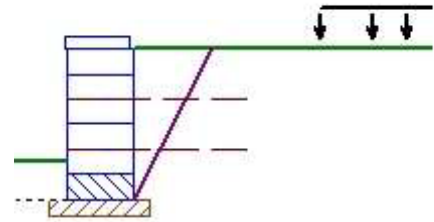
No.	Date	Revision	By	CK
1	8/22/19	Original	DPN	KMS
<div> <div>Project Number</div> <div>9696C19</div> </div> <div> <div>Figure 6</div> </div>				
<div> <div>MV Transportation Facilities Expansion</div> <div>Reinforced-Wall Detail</div> </div>				

APPENDIX A

Keystone Block Retaining Wall Calculations



Section 4 foot walls
Report Date August 16, 2019
Designer Nelson Geotechnical Associates, Inc.
Design Standard Rankine Theory Analysis
Design Static and Seismic
Unit of Measure U.S./Imperial
Selected Facing Unit Product Line: Keystone Pinned Systems
 Name: Standard 21
Seismic As 0.25 Default Deflection of 2.00 inch



Soil Zone	Phi Angle [degrees]	Cohesion [lb/ft²]	Unit Weight [lb/ft³]	Description
Reinforced	34	n/a	125.00	Sand, Silt, or Clay
Retained	32	0.00	120.00	
Foundation	32	0.00	120.00	
Leveling Pad	40	n/a	n/a	

Section Details

Section Height	4.33	Back Slope	0.00°	LL Surcharge	250	DL Surcharge	0
Design Height	4.00 ft	Crest Offset	0.00 ft	LL Offset	5.00 ft	DL Offset	0.00 ft
Embedment	1.00 ft	Wall Batter	0.00°	Toe Slope	0.00°	Toe Offset	0.00 ft

Minimum Factors of Safety

Reinforced External		Value	Internal		Value	Facing		Value
FSSl	Base Sliding	1.50	FSSl	Internal Sliding	1.50	FSCs	Connection Strength	1.50
FSbc	Bearing Capacity	2.00	FSpO	Pullout	1.50	FSsc	Facing Shear	1.50
FSct	Crest Toppling	1.50	FSto	Tensile Overstress	1.50			
FSot	Overturning	2.00						

Seismic

Reinforced External		Value	Internal		Value	Facing		Value
FSSl	Base Sliding	1.10	FSSl	Internal Sliding	1.10	FSCs	Connection Strength	1.10
FSbc	Bearing Capacity	1.50	FSpO	Pullout	1.10	FSsc	Facing Shear	1.10
FSct	Crest Toppling	1.10	FSto	Tensile Overstress	1.10			
FSot	Overturning	1.50						

Reinforcements

5XT - Miragrid 5XT		Supplier: TenCate Mirafi - Miragrid XT, Fill Type: Clays and Silts						
Tult	4,700.00 lb/ft	RFcr	1.45	RFd	1.15	LTDS	2,684.37 lb/ft	
RFid	1.05	Cds	0.70	Ci	0.70			

Connection/Shear Properties

acs1	687.00 lb/ft	IP-1	1,675.00 lb/ft	acs2	2,397.45 lb/ft	IP-2	6,000.00 lb/ft
acs max	2,397.45 lb/ft	au	1,550.00 lb/ft	lu	17.40 lb/ft	Vu(max)	4,709.00 lb/ft

Analysis Results

* Embedment is included in Bearing Capacity

External Static		FS	
Bearing Capacity	19.21	Bearing Pressure	560.17 lb/ft²
Overturning	8.34	Max Eccentricity	0.30 ft
Base Sliding	3.29		
Crest Toppling	21.94		
Internal Sliding	6.66		
External Seismic		FS	
Bearing Capacity	18.94	Bearing Pressure	568.18 lb/ft²
Overturning	7.56	Max Eccentricity	0.33 ft
Base Sliding	3.17		
Crest Toppling	8.15		
Internal Sliding	12.56		

NOTE: THESE CALCULATIONS, QUANTITIES, AND LAYOUTS ARE FOR PRELIMINARY DESIGN ONLY
AND SHOULD NOT BE USED FOR CONSTRUCTION WITHOUT REVIEW BY A QUALIFIED ENGINEER

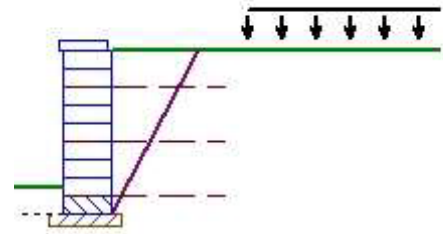


Internal Static					Tensile	Tensile	Pullout	Pullout	Conn.	Conn.
Layer	Elevation	Rein	Length	Load	Resist.	FS	Resist.	FS	Resist.	FS
2	2.67	5XT	5.00	71	2,684	37.98	288	4.08	973	13.77
1	1.33	5XT	5.00	212	2,684	12.66	800	3.77	1,259	5.94
Internal Seismic					Tensile	Tensile	Pullout	Pullout	Conn.	Conn.
Layer	Elevation	Rein	Length	Load	Resist.	FS	Resist.	FS	Resist.	FS
2	2.67	5XT	5.00	243	3,892	16.01	288	1.19	973	4.00
1	1.33	5XT	5.00	451	3,892	8.63	800	1.77	1,259	2.79

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Section 6 foot walls
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Designer Nelson Geotechnical Associates, Inc.
Design Standard Rankine Theory Analysis
Design Static and Seismic
Unit of Measure U.S./Imperial
Selected Facing Unit Product Line: Keystone Pinned Systems
 Name: Standard 21
Seismic As 0.25 Default Deflection of 2.00 inch



Soil Zone	Phi Angle [degrees]	Cohesion [lb/ft ²]	Unit Weight [lb/ft ³]	Description
Reinforced	34	n/a	125.00	Sand, Silt, or Clay
Retained	32	0.00	120.00	
Foundation	32	0.00	120.00	
Leveling Pad	40	n/a	n/a	

Section Details

Section Height	6.33	Back Slope	0.00°	LL Surcharge	250	DL Surcharge	0
Design Height	6.00 ft	Crest Offset	0.00 ft	LL Offset	5.00 ft	DL Offset	0.00 ft
Embedment	1.00 ft	Wall Batter	0.00°	Toe Slope	0.00°	Toe Offset	0.00 ft

Minimum Factors of Safety

Reinforced External		Value	Internal		Value	Facing		Value
FSSl	Base Sliding	1.50	FSSl	Internal Sliding	1.50	FScs	Connection Strength	1.50
FSbc	Bearing Capacity	2.00	FSpO	Pullout	1.50	FSsc	Facing Shear	1.50
FSct	Crest Toppling	1.50	FSto	Tensile Overstress	1.50			
FSot	Overturning	2.00						

Seismic

Reinforced External		Value	Internal		Value	Facing		Value
FSSl	Base Sliding	1.10	FSSl	Internal Sliding	1.10	FScs	Connection Strength	1.10
FSbc	Bearing Capacity	1.50	FSpO	Pullout	1.10	FSsc	Facing Shear	1.10
FSct	Crest Toppling	1.10	FSto	Tensile Overstress	1.10			
FSot	Overturning	1.50						

Reinforcements

5XT - Miragrid 5XT		Supplier: TenCate Mirafi - Miragrid XT, Fill Type: Clays and Silts					
Tult	4,700.00 lb/ft	RFcr	1.45	RFd	1.15	LTDS	2,684.37 lb/ft
RFid	1.05	Cds	0.70	Ci	0.70		

Connection/Shear Properties

acs1	687.00 lb/ft	IP-1	1,675.00 lb/ft	acs2	2,397.45 lb/ft	IP-2	6,000.00 lb/ft
acs max	2,397.45 lb/ft	au	1,550.00 lb/ft	lu	17.40 lb/ft	Vu(max)	4,709.00 lb/ft

Analysis Results

* Embedment is included in Bearing Capacity

External Static		FS	
Bearing Capacity	12.66	Bearing Pressure	915.31 lb/ft ²
Overturning	5.26	Max Eccentricity	0.57 ft
Base Sliding	2.60		
Crest Toppling	21.94		
Internal Sliding	3.47		
External Seismic		FS	
Bearing Capacity	12.49	Bearing Pressure	928.14 lb/ft ²
Overturning	4.97	Max Eccentricity	0.60 ft
Base Sliding	2.54		
Crest Toppling	8.15		
Internal Sliding	4.58		

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Internal Static					Tensile	Tensile	Pullout	Pullout	Conn.	Conn.
Layer	Elevation	Rein	Length	Load	Resist.	FS	Resist.	FS	Resist.	FS
3	4.67	5XT	6.00	96	2,684	27.90	278	2.89	973	10.11
2	2.67	5XT	6.00	236	2,684	11.39	1,114	4.73	1,402	5.95
1	0.67	5XT	6.00	375	2,684	7.16	2,452	6.54	1,831	4.88
Internal Seismic					Tensile	Tensile	Pullout	Pullout	Conn.	Conn.
Layer	Elevation	Rein	Length	Load	Resist.	FS	Resist.	FS	Resist.	FS
3	4.67	5XT	6.00	250	3,892	15.59	278	1.12	973	3.90
2	2.67	5XT	6.00	481	3,892	8.09	1,114	2.32	1,402	2.91
1	0.67	5XT	6.00	642	3,892	6.06	2,452	3.82	1,831	2.85

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